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THE RIVERS OF NORTHERN NEW JERSEY, WITH NOTES ON THE CLASSIFICATION OF RIVERS IN GENERAL.

By William Morris Davis.

Outline.—Rivers of different kinds: consequent, anteecedent, superimposed, subsequent, adjusted.—Topography of Northern New Jersey.—Revived and superimposed rivers in New Jersey.—Drainage of the Watchung crescent.—Re-arrangement of superimposed rivers by the growth of subsequent streams.—Application of this principle to the Green river in the Uinta mountains: Powell's and Emmons' theories.—The Green river probably superimposed and its branches re-arranged by the growth of subsequent streams.—Anaclinal and reversed rivers in New Jersey.

Northern New Jersey is drained by several streams which rise in the Archean Highlands, flow southeastward across the central Triassic plain and reach the sea near the inland margin of the Cretaceous formation.

What kinds of rivers are these? Such a question can hardly be answered until we have examined rivers in many parts of the world, gaining material for a general history of rivers by induction from as large as possible a variety of examples; and until we have deduced from our generalizations a series of critical features sufficient to serve for the detection of rivers of different kinds wherever found.

The generalizations here referred to may be presented in the form of a classification, following the ideas of Powell, Gilbert, Heim, Löwl and others, as follows :

Consequent rivers.—Those that have in their birth, at the time of their original establishment on the country which they drain, selected courses in accordance with the constructional slopes of the surface ; for example, the Red River of the North and such of its branches as flow on the even surface of the lacustrine plain of Lake Agassiz ; the several streams that drain the broken lava blocks of Southern Oregon ; certain streams and rivers of the Jura that drain the synclinal troughs of those mountains. Consequent streams may be divided into definite and indefinite groups. Definite consequent streams are those that follow well defined constructional channels, such as the axial line of a synclinal trough, or the lowest point of an anticlinal arch between two synclinal basins ; they are defined in location as well as in direction. Indefinite consequent streams are those that flow down constructional slopes, such as the flanks of an anticline, but whose precise location depends on those minor inequalities of surface that we term accidental ; they are defined in direction but not in location ; and they are as a rule branches of definite consequent streams.

Antecedent rivers.—Those that during and for a time after a disturbance of their drainage area maintain the courses that they had taken before the disturbance. In Powell's original definition of this class of rivers, he said that the valleys of the Uinta mountains are occupied by "drainage that was established antecedent to the corrugation or displacement of the beds by faulting or folding."* No limit is set to the amount of corrugation or displacement or to the strength of the faulting or folding. It therefore seems advisable to consider what variations there may be from the strongly marked antecedent type ; one extreme being in those cases where the displacement was a minimum and the perseverance of the streams a maximum, the other where the displacement was a maximum and the successful perseverance of the streams a minimum, or zero. The simplest examples of antecedent rivers are therefore found in regions that have been broadly elevated with the gentlest changes of slope, so as to enter a new cycle of topographic development, all the streams retaining their previous courses, but gaining ability to deepen their former chan-

* Colorado river of the West, 163.

nels down to the new baselevel; such streams may be called "revived." Examples of revived streams are very common; nearly all the streams of the Highlands of New Jersey are of this kind; all the streams of central and western Pennsylvania seem to belong in the same class. From these simple and common examples, we shall some day, when our knowledge of rivers is better developed, be able to form a complete series leading to what is generally understood as the typical antecedent river, which has outlived deformation as well as elevation without suffering either deflection or ponding. Large rivers of strong slope, well enclosed in steep-sided valleys, or in other words vigorous adolescent rivers have the best opportunity to persist across a belt of rising or writhing country,* because a great deformation would be required to throw them from their courses. Small streams or large ones of faint slope in an open low country are more easily deflected. From the typical antecedent river, the series may be continued by examples in which even the larger streams are less or more ponded or deflected by the deformation, until at the end of the series there is a complete extinction of the antecedent drainage and the establishment of an entirely original consequent drainage. The perfectly typical antecedent river, in the middle of this series, is certainly of rare occurrence, and is perhaps unknown.

Consequent streams, whose course is taken on a relatively thin, unconformably overlying mass, for a time preserve their initial courses, even though they may be quite out of accord with the underlying structures on which they have descended. Such streams were first recognized by Marvine, and afterwards named "superimposed," "inherited" or "epigenetic" by various authors. A full collection of examples of this class should begin with streams that depart from true consequent courses only locally, where they have discovered a small portion of the underlying formation, like the Merrimack at Manchester and other water-power towns of New Hampshire, where the stream has sunk upon rocky ledges beneath the surface drift and sands; or like the Mississippi and other rivers in Minnesota which have in places cut through the drift sheet to the underlying crystallines. The series would conclude with streams that have stripped off the cover on which they were consequent, and have thus become superimposed on the underlying formation in their whole length.

* Stur's expression "Gebirgshub oder Gebirgschub" suggested to me the terms here employed.

There is a curious intermediate type of drainage lately recognized by McGee in the southern states, a superimposed drainage that is not inconsequent upon the buried surface beneath the unconformably overlying surface layer. It occurs in regions where a well-marked drainage had been established; a brief submergence then allowed the deposition of a relatively thin mask of sediments; an elevation brought the masked surface up again, and as it rose, the streams took possession of lines essentially identical with the courses of their ancestors, because the mask of newer deposits had not extinguished the antecedent topography. McGee proposes to call such streams "resurrected."

Rivers of all classes as a rule develop during their adolescence and more mature growth certain "subsequent" branches that were not in any way represented in the early youth of the system. Thus the indefinite members of the consequent drainage of the Jura mountains have developed subsequent streams on soft beds of monoclinal and anticlinal structures, where there could not possibly have been any consequent drainage lines at the birth of this system, unless we admit the supposed fracturing of the anticlinal crests, which seems unnecessary to say the least. Even in the simplest style of drainage, growing on a level surface, many of the branches must be "subsequent," or as McGee has called them in such cases, "autogenetic."

Rivers of all classes are subject to spontaneous re-arrangement or adjustment of their courses to a greater or less extent, in accordance with the weaker structural lines. This results from the migration of divides and the consequent abstraction or capture of one stream by another. The capture is generally made by the headward development of some subsequent branch. But after this kind of change has advanced to a certain extent, the divides become stable, and further change ceases. The rivers may then be said to be maturely adjusted. Under certain conditions, chiefly great initial altitude of surface, and great diversity of structure, that is, in mountainous regions, the changes arising from adjustments of this spontaneous kind are very great, so that the courses of a river's middle age may have little resemblance to those of its youth, as Löwl has pointed out and as I have tried to show in the case of the Pennsylvanian rivers. It may be difficult to recognize in such cases whether the youthful courses of a river system were consequent, antecedent or superimposed. Adjustments of this kind were not discussed by Powell, although he

makes brief mention of what I have called subsequent streams. The first appreciation that I gained of river adjustments came from the writings of Löwl; but I have since found that the general principles governing their opportunity were stated by Gilbert in his monograph on the Henry Mountains of Utah (pp. 141, 149), and by Heim in his Mechanismus der Gebirgsbildung (i, 272, etc., ii, 79, 320).

Where do the rivers of northern New Jersey stand in this general scheme of river classification? We must again postpone the answer to the question, while reviewing the history of the general geographical development of the region.*

The topography of northern New Jersey may be briefly described as made up of valleys and lowlands that have been etched in the now elevated surface of what may be called the Schooley peneplain on the Cretaceous baselevel. The topographical atlas of New Jersey should be constantly referred to, in order to follow such a statement as this; but in order that the reader may without undue difficulty apprehend the meaning of my descriptions and recognize the various localities yet to be named without the trouble of searching for them on the maps of the atlas, I have attempted to draw a generalized bird's eye view of northern New Jersey, as it would be seen by an observer about seventy miles vertically above the center of southern New Jersey. The meridians are vertical and east and west lines are horizontal, but oblique azimuths are foreshortened. The result is hardly more than a geographical caricature, and I publish it in part to experiment upon the usefulness of so imperfect an effort. An active imagination may perceive the long even crest line of Kittatinny Mountain on the northwest, rising beyond the rolling floor of the Kittatinny Valley, as the great Alleghany limestone lowland is here called; then come the Highland plateaus, of accordant altitude one with another, but without the mesa-like margin that my pen has not known how to avoid indicating. The Central plain lies in the foreground, diversified by the various trap ridges that rise above its surface; First and Second mountains of the double Watchung

* The more detailed statement of this history may be found in an essay prepared by the author with the collaboration of Mr. J. W. Wood, Jr., of the class of 1888 in Harvard College, the study being undertaken as a joint thesis by instructor and student in a second course in Physical Geography. The essay is published in the Proceedings of the Boston Society of Natural History, 1889.

crescent near the Highlands; Sourland Mountain in the southwest; and Rocky Hill, the southwestern re-appearance of the Palisades intrusive trap sheet, lying a little nearer to us. The Central plain is also diversified by the Fall-line, a slight but rather distinct break in its surface from Trenton (Tr.) on the Delaware to a little below New Brunswick (N. B.) on the Raritan. The important drainage lines are: the Delaware, forming the western boundary of the State, trenching Kittatinny Mountain at the Water Gap, cutting a deep transverse valley through the Highlands where it receives longitudinal branches, and a shallower trench across the Kittatinny lowland and the Central plain; the Raritan, whose north and south branches head in the Highlands, while the Millstone joins it from south of the fall-line, cutting through Rocky Hill near Princeton (Pr) on the way; and the Pequannock-Passaic, rising in the Highlands, gathering tributaries in the low basin behind the Watchung ridges, and escaping to the front country as a single stream, the Passaic, through deep gaps at Patterson. The terminal moraine, marking the furthest advance of the second glacial invasion of post-tertiary time, is indicated by an irregular dotted band crossing the State, from the Narrows of New York Bay, which it defines, on the east, passing over Second Mountain by the gap at Summit (S), rising midway in the Highlands over Schooley Mountain, and traversed by the Delaware at Belvidere (B).

The Schooley peneplain is indicated by the crest and summit altitudes of Kittatinny Mountain, the Highland plateaus and the trap ridges. This peneplain once lay low and essentially horizontal, the practically completed work of the processes of denudation acting on a previously high land through a long period of time: it is now lifted and tilted, so that its inland portion rises to the height of the Highlands, which are its remnants, while its seaward portion descends slowly beneath a cover of unconformable Cretaceous beds, southeast of the fall-line, and thus hidden sinks gently beneath the Atlantic shore. The cover of Cretaceous sediments was laid on the southeastern part of the old peneplain during a moderate submergence of its seaward portion, before the elevation and tilting above mentioned (fig. 2, p. 93). Much of the cover has been worn away since the time of elevation (figs. 3–6, p. 95), which gave opportunity for the opening of deep valleys on the soft limestones and slates among the hard crystalline rocks of the Highlands; and for the production of the broad

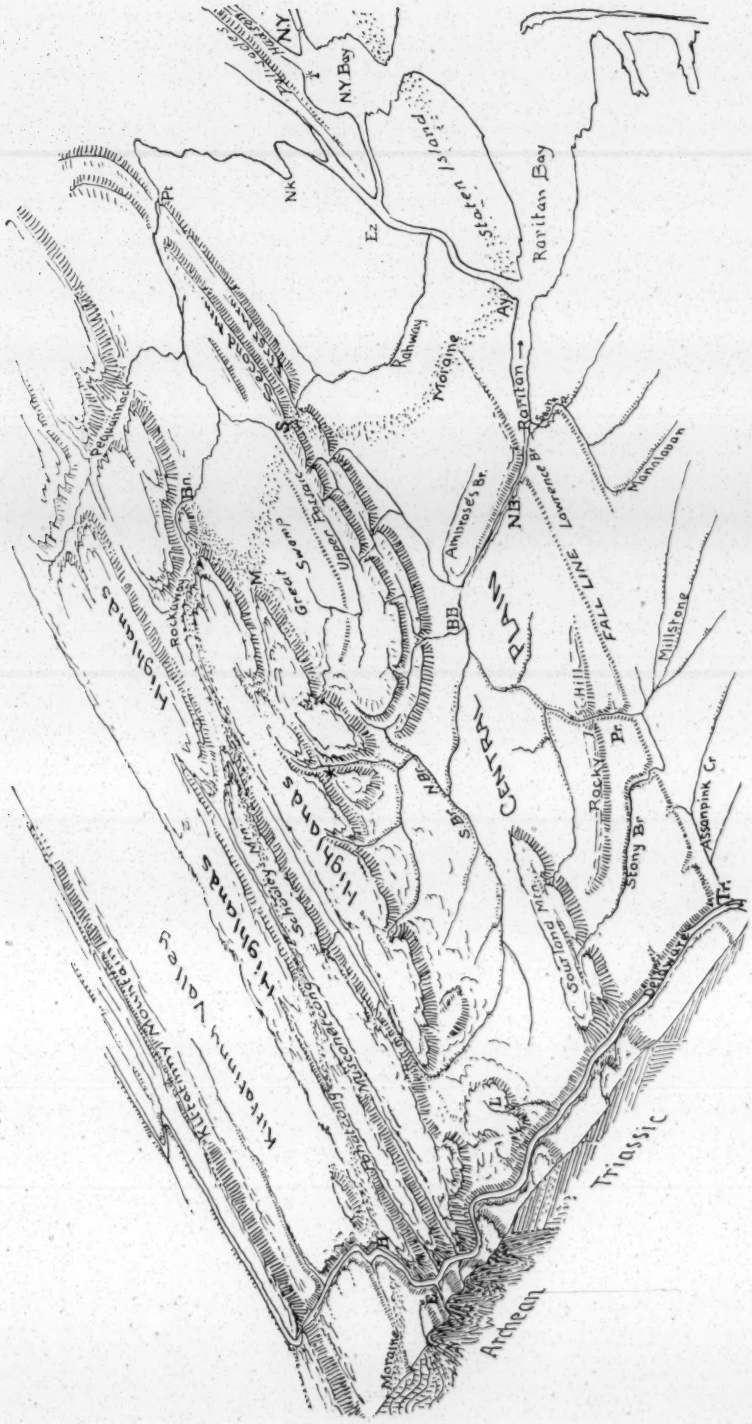

N.Y.
N.Y. Bay
Staten Island
Raritan Bay
Nk
Ez
Pt
Rahway
Moraine
Ay
Raritan
Manalapan
Lawrence Br
Ambrose's Br.
NB
FALL LINE
Millstone
Pequannock
Bn.
Great Swamp
Upper Passaic
M
BB
CENTRAL PLAIN
Highlands
Rockaway
Hill
Rocky
Pr
Stony Br
Assanpink Cr
Tr.
Delaware
Sourland Mtn
Highlands
Highlands
Kittatinny Valley
Kittatinny Mountain
Triassic
Archean
Moraine

FIG. 1.

Kittatinny Valley lowland or peneplain on the wide belt of limestones beyond the Highlands; and furthermore for the development of a broad baselevelled plain on the weak Triassic shales and sandstones, where the old peneplain has been almost entirely destroyed. The Cretaceous cover remains only near the coast, where it stood too low to be attacked while the valleys and lowlands just described were carved out. An interesting peculiarity in the relation between the newer baselevel plain on the Triassic area and the old Cretaceous peneplain is that their surfaces mutually intersect at a small angle along the line which now marks the visible contact between the Triassic and Cretaceous formations: the newer plain standing beneath the eroded portion of the older one northwest of this line, while it rises above the buried part of the older one and obliquely truncates its Cretaceous cover to the southeast of the line. Finally, the land as a whole has been raised a little since the making of the newer plain, and shallow valleys interrupt its broad surface. It is no longer a true plain; it has become a pastplain. A few words may be allowed me concerning these terms, peneplain and pastplain. Given sufficient time for the action of denuding forces on a mass of land standing fixed with reference to a constant baselevel, and it must be worn down so low and so smooth, that it would fully deserve the name of plain. But it is very unusual for a mass of land to maintain a fixed position as long as is here assumed. Many instances might be quoted of regions which have stood still so long that their surface is almost reduced to its ultimate form; but the truly ultimate stage is seldom reached. We can select regions in which the valley lowlands have become broad and flat, the intermediate "doab" hills have wasted away lower and lower until they are reduced to forms of insignificant relief; and yet the surface still does not deserve the name of plain as unqualifiedly as do those young lands newly born from seas or lakes in which their geometrically level surfaces were formed. I have therefore elsewhere suggested* that an old region, nearly baselevelled, should be called an almost-plain; that is, a peneplain.

On the other hand, an old baselevelled region, either a peneplain or a truly ultimate plain, will, when thrown by elevation into a new cycle of development, depart by greater and greater degrees from its simple featureless form, as young narrow valleys

* Amer. Jour. Sci., xxxvii, 1889, 430.

are sunk beneath its surface by its revived streams. It therefore no longer fully deserves the name that was properly applicable before its elevation. It must not again be called a peneplain, for it is now not approaching and almost attaining a smooth surface, but is becoming rougher and rougher. It has passed beyond the stage of minimum relief, and this significant fact deserves implication, at least, in a name. I would therefore call such a region a pastplain. The area of the weak Triassic shales was, until its late elevation, as good an example of an ultimate baselevelled plain as any that I have found; but now it is a pastplain, as any one may see while traveling across it on the train: its doabs are broad and continuous, and its valleys are relatively narrow and shallow. The Kittatinny lowland is intersected by streams whose valleys sink below its generally even, gently rolling surface; but it was never so smooth as the Triassic plain. It was only a peneplain, and it is now a roughened peneplain. Perhaps the more adventurous terminologist will call it a past-peneplain; but I dare not venture quite so far as that. When the Highlands were lowlands, their surface well deserved the name of peneplain; but they were lifted so long ago into so high a position that they are now cut into a complicated mass of rugged uplands. They no longer deserve the name of peneplain; and if in preceding paragraphs I have referred to them as constituting an old peneplain, it is because no satisfactory name has yet been applied to the particular stage of development of plains and plateaus in which they now stand. Having tried in vain to invent a term with which to name the Highlands, let me now advertise for one in the pages of our Magazine.

WANTED: a name applicable to those broken, rugged regions that have been developed by the normal processes of denudation from the once continuous surface of a plain or peneplain. The name should be if possible homologous with the words, *plain*, *peneplain* and *pastplain;* it should be of simple, convenient and euphonious form; it must be satisfactory to many other persons than its inventor; and its etymological construction should not be embarrassed by the attempt to crowd too much meaning into it. The mere suggestion that it was once a plain and that it is now maturely diversified will suffice.

The topography of northern New Jersey is therefore, like its structure, polygenetic. It exhibits very clearly a series of forms developed under three different geographic cycles, and closer search will doubtless discover forms belonging to yet other cycles,

less complete and of briefer duration than these three. There is the tilted and deeply eroded peneplain of the Highlands, whose initial form may be called the Schooley peneplain, from the distinct exhibition of one of its remnants on Schooley's mountain; this was the product of Jurassic and Cretaceous denudation. There is the younger central baselevelled plain, developed during Tertiary time, or thereabouts, on the weaker Triassic and Cretaceous beds; and the associated valleys of the same age that have been sunk into the weakest rocks of the Highlands. There are the shallow valleys in the Central plain, of the latest post-tertiary cycle, requiring the name of this region to be changed from plain, as it was lately, to pastplain, as it is now. The first cycle, in which the Schooley peneplain was produced, witnessed the accomplishment of a great work; it included in its later part, besides various other oscillations, the sub-cycle when the seaward or southeastern part of the peneplain was gently submerged and buried to a slight depth under Cretaceous deposits. The second cycle was shorter; being a time sufficient to baselevel the softer beds, but not seriously to consume the harder parts of the preexisting surface. We are still in the third cycle, of which but a small part has elapsed. The question with which this essay opened may now be taken up.

The streams and rivers of northern New Jersey may be examined, with the intention of classifying them according to their conditions of origin, to their degree of complexity as indicated by the number of geographic cycles through which they have lived, and to the advance made toward their mature adjustment.

The Musconetcong may be taken as the type of the Highland streams. It flows southwestward along a narrow limestone valley between crystalline plateaus on either side, entering the Delaware a little below Easton, Pa., (E, fig. 1). It drains a country that has been enormously denuded, and during the Jura-Cretaceous cycle of this deep denudation, there must have been time for it and its fellows to become thoroughly adjusted to the structure of the region; it must be chiefly for this reason that it flows so closely along the weak limestone belt, and has its divides close by on the adjoining harder crystallines, (M, fig. 2). Whatever its origin, it has lost every initial feature that was discordant with the deep structures that it discovered beneath the initial surface; it is maturely adjusted to its environment. It endured

to an old age during the baseleveling of the Schooley peneplain, and is now a "revived" stream, in at least its second cycle of work. Most of the other streams of the Highlands and the country farther inland are also of this well adjusted, revived kind. The streams of the Kittatinny valley lowland show not only the first revival of the kind just described, but also a second revival, in consequence of the recent uplift that has introduced the third cycle of development; this not being so clearly manifested in the Highlands, where the rocks are harder, and the valleys of the second cycle are narrower.

Look now at the drainage of the crescentic Watchung mountains; the curved edges of two great warped lava-flows of the Triassic belt. The noteworthy feature of this district is that the small streams in the southern part of the crescent rise on the back slope of the inner mountain and cut gaps in both mountains in order to reach the outer part of the Central Plain. If these streams were descended directly or by revival from ancestors antecedent to or consequent upon the monoclinal tilting of the Triassic formation, they could not possibly, in the long time and deep denudation that the region has endured, have down to the present time maintained courses so little adjusted to the structure of their basins. In so long a time as has elapsed since the tilting of the Triassic formation, the divides would have taken their places on the crest of the trap ridges and not behind the crest on the back slope. They cannot be subsequent streams, for such could not have pushed their sources headwards through a hard trap ridge. Subsequent streams are developed in accordance with structural details, not in violation of them. Their courses must have been taken *not long ago*, else they must surely have lost their heads back of the second mountain; some piratical subsequent branch of a larger transverse stream, like the Passaic, would have beheaded them.

The only method now known by which these several doubly transverse streams could have been established in the not too distant past, is by superimposition from the Cretaceous cover that was laid upon the old Schooley peneplain. It has already been stated that when the Highlands and this region together had been nearly baseleveled, the coastal portion of the resulting peneplain was submerged and buried by an unconformable cover of waste derived from the non-submerged portion: hence when the whole area was lifted to something like its present height, a

new system of consequent streams was born on the revealed sea bottom. Since then, time enough may have passed to allow the streams to sink their channels through the unconformable cover and strip it off, and thus superimpose themselves on the Triassic rocks below: we should therefore find them, in so far as they have not yet been re-adjusted, following inconsequent, discordant courses on the under formation. The existing overlap of the Cretaceous beds on the still buried Triassic portion of the old Schooley peneplain makes it evident that such an origin for the Watchung streams is possible; but it has not yet been independently proved that the Cretaceous cover ever reached so far inland as to cross the Watchung ridges.

Want of other explanation for the Watchung streams is not satisfactory evidence in favor of the explanation here suggested. There should be external evidence that the Triassic area has actually been submerged and buried after it was baselevelled to the Schooley peneplain and before it was uplifted to its present altitude; other streams as well as the ones thus far indicated, should bear signs of superimposition; and if adjustment of the superimposed courses has begun, it should be systematically carried farthest near the largest streams. I shall not here state more than in brief form, the sufficient evidence that can be quoted in favor of the first and second requisites. Suffice it to say that the overlap of the Cretaceous beds (which contain practically no Triassic fragments) on the bevelled Triassic strata at Amboy and elsewhere indicates submergence after baselevelling; and that the pebbles, sands and marls of the Cretaceous series point clearly to the Highlands as their source. The submergence must therefore have reached inland across the Triassic formation at least to the margin of the crystalline rocks. Some shore-line cutting must have been done at the margin of the Highlands during Cretaceous time, but the generally rolling surface of the old peneplain leads me to ascribe its origin chiefly to subaërial wasting. Moreover, the North Branch of the Raritan, between Mendham and Peapack (* Fig. 1) and the Lockatong (L), a small branch of the Delaware on the West Hunterdon sandstone plateau, give striking indications of superimposition in the discordance of their courses with the weaker structural lines of their basins, so unlike the thoroughly adjusted course of the Musconetcong and its fellows, the Pohatcong, the Lopatcong, and others.

The third requisite of the proof of the inland extension of the Cretaceous, and the resulting superimposed origin of the Watchung streams may be stated in detail, as being more in the line of this essay: has the adjustment that accompanies superimposition systematically advanced farther near the large streams than near the small ones? The character of this adjustment should be first examined deductively. Given a series of streams of different volumes, flowing southeastward, in the direction of the present dip of the remnant of the Cretaceous cover, over the former inland extension of this superposed formation; how will these streams react on one another when they sink their channels into the underlying Triassic formation?

The conditions during the formation of the cover of Cretaceous beds are illustrated in fig. 2, where the Triassic portion of the

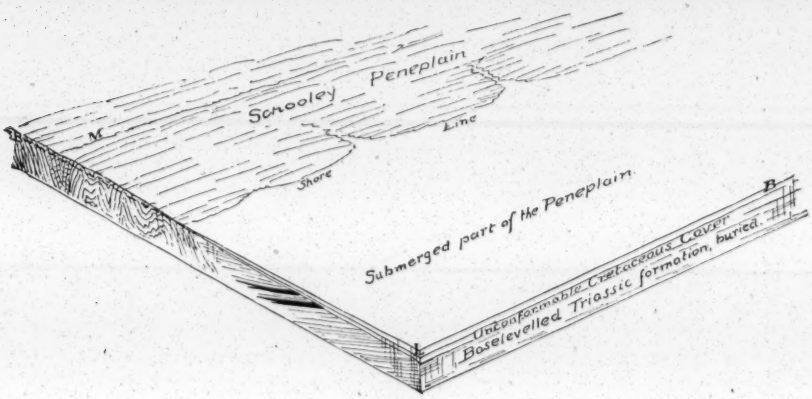


FIG. 2.

peneplain is submerged, and the shore-line of the transgressing ocean has reached the margin of the crystalline rocks. The waste from the crystallines is spread out as a series of gravels, sands and marls on the baselevelled Triassic area.

Then follows the elevation and tilting of the peneplain with the cover on its back; and with this regression of the sea, there is an equivalent gain of new land; a smooth gently sloping plain is revealed as the shore line retreats; streams run out across it from the crystalline area, or begin on its open surface, growing mouthward as the land rises. Three such streams, A, C, D, are shown in fig. 3; their opportunity for deep valley-cutting is indicated by the depth of the new baselevel, BL, below the general

surface of the country. While these streams are deepening their channels in the Cretaceous cover, which is unshaded with marginal contour lines in the figures, their subsequent, autogenetic branches are irregularly disposed, because there is no lateral variation of structure to guide them; but after a time, the baselevelled surface of the buried Triassic beds is reached, as is shown by linear shading in the valley bottoms of figs. 4, 5, 6, 7. The growth of the subsequent branches then developed, will be along the strike of the Triassic softer beds, that is, about square

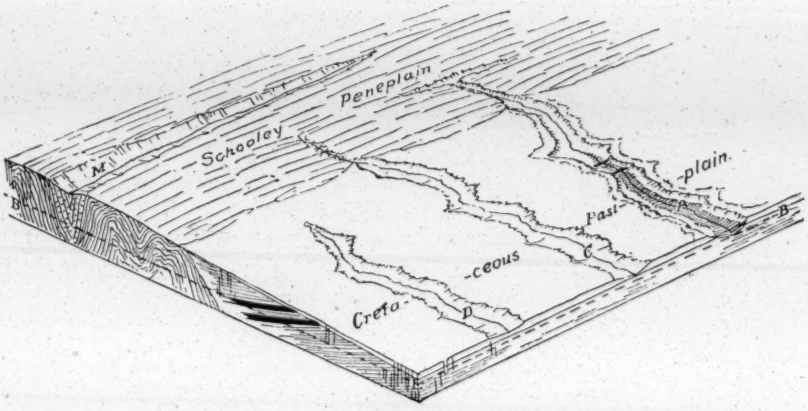


FIG. 3.

to the course of the three transverse streams under consideration. The most rapid growth will be found on the branches of the largest stream, A, because it will most quickly cut down its channel close to the baselevel of the time and thus provide steep sloping valley-sides, from which the subsequent branches cut backwards most energetically. In due time the main streams discover the particularly resistant transverse lava sheets in the underlying formation; and then the subsequent branches of the largest transverse stream on the up-stream side of the obstructions, for example, F and G, fig. 4, will have a great advantage over those of the smaller streams. The most rapidly growing subsequent branch, G, fig. 5, of the largest transverse master stream, A, may grow headwards so fast as to push away the divide, X, which separates it from the head of the opposing subsequent branch, J, of the next adjacent smaller transverse stream, C, and thus finally to capture and divert the headwaters, H, of the smaller transverse stream to the larger one, as in fig. 6.

The divide creeps while the two opposing subsequent branches are in contest ; it leaps when the successful subsequent branch reaches the channel of the conquered stream. The first stream captured in this way must necessarily be the nearest to the large stream. The diversion of the considerable volume of headwaters, H, to the channel of the small subsequent branch, G, causes it to

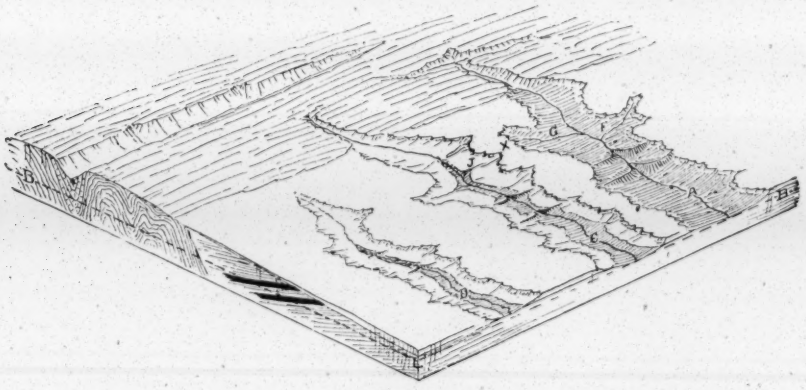


FIG. 4.

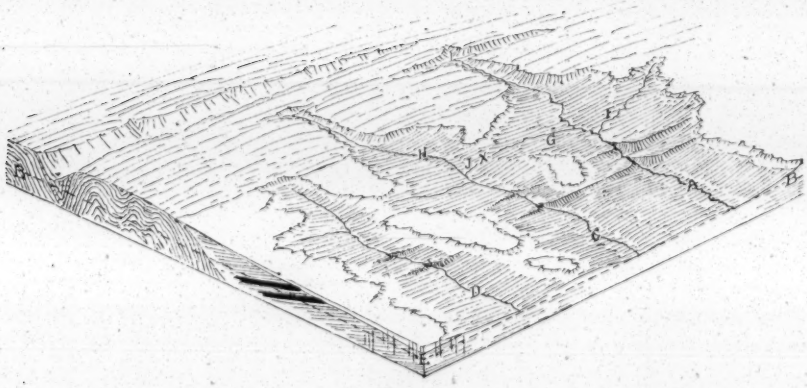


FIG. 5.

deepen its channel rapidly; the same effect is perceptible in H for a distance above its point of capture and diversion : the increased load of sediment thus given to G will be in great part dropped in a fan-delta where it enters the flat valley of the master stream, A, (fig. 6).

Gaining strength by conquest, other captures are made, faster for a time, but with decreasing slowness as the head of the divert-

ing subsequent branch recedes from the original master: and at last, equilibrium may be gained when the headwater slope of the diverting branch is no greater than that of the opposing subsequent branch of the next uncaptured transverse stream. After the capture of a transverse stream has been effected in this way, the divide, Y, between its diverted upper portions, H, fig. 6, and

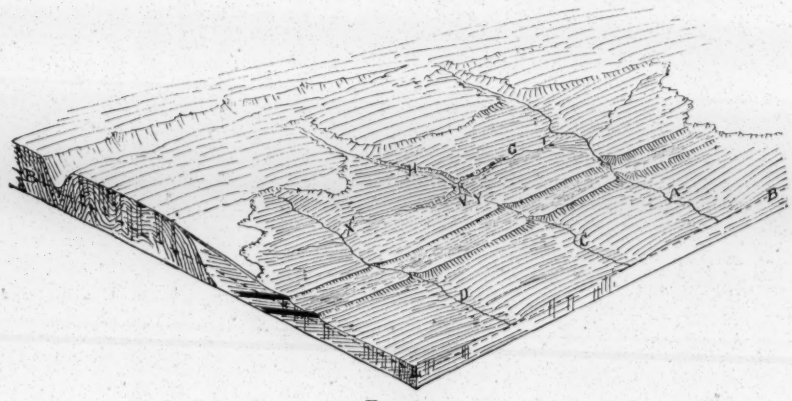


FIG. 6.

its beheaded lower portion, C, will be pushed down stream by the growth of an inverted stream, V. This goes on until equilibrium is attained and further shifting is prevented on reaching the hard transverse lava sheets, Z, fig. 7; here the divide is maturely

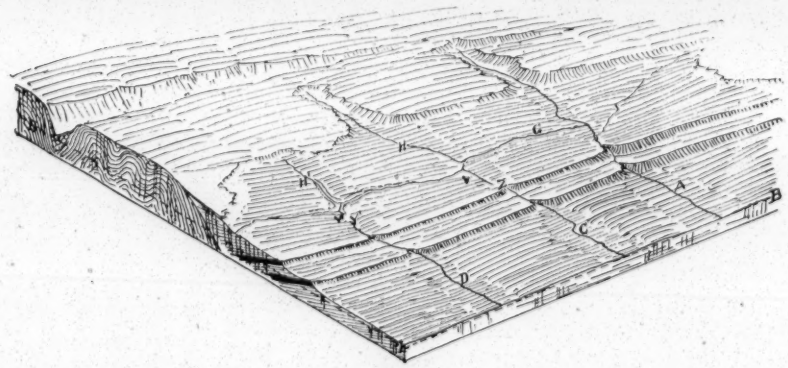


FIG. 7.

established. In the case of a system of transverse streams, C, D, etc., fig. 7, successively captured by the subsequent branch of a single master, the divides (Z, Y'), between the inverted (V, V')

and beheaded (C, D) portions of the captured streams will for a time present different stages of approach to establishment. The divide on the line of that one of the original streams, C, that is nearest to the master stream, A, may reach a final stable position, Z; while on the next stream further away from the master, the beheaded portion, D, may still retain a short piece above the gap in the upper lava sheet, not yet secured by the inverted stream, V′; and a third stream, further away still from the master (not shown in figure 7) might remain uncaptured and independent.

It is by such tests as these that we may hope to recognize the occurrence of partial adjustment in the streams of the Watchung crescent as a result of their superimposition on the Triassic formation from its former Cretaceous cover. The greater the degree of complexity in the tests proposed, the more confidence we shall have in the theory when the tests successfully meet the facts. Hence the reason for deductively carrying out the theoretical conditions to their extremest consequences in order to increase the complexity of the tests that are to be confronted with the facts. This, as a matter of method, seems to me of great practical importance in any attempt to decipher the past progress of geographical development.

The admirable contoured topographic maps of New Jersey, issued by the Geological Survey of that state under the leadership of the late Professor George H. Cook, afforded means of applying the deductive tests above outlined without the necessity of plodding over all the country concerned; but however good the maps are, it is hardly necessary to say that they can be interpreted with a better appreciation of the facts that they represent after an excursion on the ground has given the student some personal acquaintance with it. This I have tried to gain on various occasions, maps in hand.

Atlas sheet number six, including the Central red-sandstone area, and the five-mile-to-an-inch geological map of the state present in the clearest manner the facts of form and structure involved in our problem; and to my mind, the correspondence between theory and fact is very striking. The Pequannock-Passaic is the master transverse stream of the region: its preëminence was probably due in the beginning to its gathering, from the unsubmerged Highlands, a greater amount of drainage than belonged to any other stream that ran southeastward down the gen-

tle slope of the newly revealed Cretaceous cover. It was at that time a compound, composite river :* compound because it drained areas of different ages ; composite, because these areas were of different structures. Existing examples of compound, composite rivers are seen in the Catawba, the Yadkin-Pedee, the Cape Fear and the Neuse rivers of North Carolina, which all rise on the inland crystalline area, and traverse the coastal quaternary plain before reaching the sea. But unlike these, there must have been, when the old submerged land rose with the Cretaceous cover on its back, numerous small streams whose drainage area lay entirely within the Cretaceous plain. These were simple streams, flowing over a structure of one kind and one age. Their modern homologues are seen in the Maurice, the Great and Little Egg Harbor and the Wading rivers of southern New Jersey, and I suppose also in various relatively short streams of North Carolina, such as the Lumber, Great Cohera and Moccassin.

It cannot be supposed that the original Pequannock-Passaic possessed the large southern branch, which I shall call the upper Passaic, by which Great Swamp is now drained ;† for had this been the case, the divides between the branches of the upper Passaic and the heads of the small streams that now still cross both of the trap ridges, must have long ago been driven to a stable position on the crest line of the inner ridge. The upper Passaic member of the Pequannock-Passaic system must be regarded as a branch of subsequent development, guided by some of the softer Triassic beds when they were reached beneath the Cretaceous cover, and very successful in capturing and diverting other transverse streams that were smaller than its master. For some distance on either side from the Pequannock-Passaic gap in the trap ridges at Patterson, the existing streams are perfectly adjusted to the Triassic structure ; that is, the ridges are persistent divides, and the lateral subsequent branches of the master flow along the strike of the softer shales and sandstones, except where lately thrown off their courses by glacial drift barriers. This I interpret as meaning that the Pequannock-Passaic master

*See terminology suggested by the author. Nat. Geogr. Mag., i, 1889, 218.

† It should be recognized that the present round-about drainage of the Great Swamp is a post-glacial feature, determined by the morainic barrier that crosses the basin from Summit (S) to Morristown (M) : the preglacial drainage of the southern part of the inner crescent was undoubtedly of a simpler and more direct pattern.

stream hereabouts made so early a capture of adjacent superimposed streams that all traces of their initial discordant courses have been obliterated by the development of structurally accordant subsequent streams.

The Watchung ridges extend only about eight miles northward of the Paterson gaps, but reach thirty miles southwestward. It is therefore chiefly in the latter direction that we may expect to find examples of incomplete adjustment following superimposition and capture. At Milburn, there is a deep gap in First mountain, and opposite this at Summit (S, fig. 1) a partly drift-filled gap in Second mountain: this I am disposed to regard as the former outlet of the Rockaway-Rahway river, which on account of its considerable size was not captured by the Passaic until it had cut its passage across the trap sheets almost to a safe depth. The diverted upper portion—the Rockaway—now joins the Passaic; its crooked course from the Highlands via Boonton (Bn) being a post-glacial irregularity; the beheaded lower portion—the Rahway—heads on the ridge of Second mountain, retains the pair of subsequent streams between the two ridges, and flows in diminished volume to the sea: the divide between the two portions being in its mature stable position on Second mountain.

South of the Milburn gap, there are three streams that maintain water gaps in First mountain, and five head branches of these three streams rise behind the crest of Second mountain. These must be interpreted as remnants of streams that once rose further inland, and whose upper courses have been captured by the victorious upper Passaic; but it is noteworthy that here, at the greatest distance from the gap of the master stream at Paterson, the divides between the diverted and beheaded portions of these southern streams should lie in unstable positions, back of the crest line of Second mountain. This is exactly what the hypothesis of a superimposed origin for these streams would require; and if the complexity of accordance between deduction and fact here presented be duly considered, I believe new confidence may be gained in the hypothesis of superimposition, already rendered likely from other evidence.

The rectangular courses of the streams that cross First and Second mountains southwest of Milburn do not militate against their initial obliquely superimposed courses; for, as Gilbert has shown, oblique courses across tilted beds, alternately hard and soft, will gradually shift until they follow rectangular courses,

along the strike of the soft beds and square across the strike of the hard beds. Middle Brook, at the southern bend of First mountain near Bound Brook (B, B), presents the peculiarity of branching east and west while on the trap sheet of the mountain: this may be due to a retention here, where the dip is moderate, of an initially superimposed bifurcation; or to guidance by fractures at this point where the course of the mountain changes rather abruptly; the facts at hand do not serve to make choice between these alternatives.

The lesson of greatest importance in this study lies, to my mind, in the gradual development of accordant subsequent streams in a region where the unchanged superimposed drainage would show no such accordance. Similar adjustment of subsequent streams to structural features may characterize drainage systems that were originally antecedent: and with this principle in mind, I have recently read over with renewed interest Powell's classic study of the Green river where it crosses the Uinta mountains.* The Green river and the smaller streams of its lateral cañons and valleys are all regarded as antecedent. Let us examine the arguments on which this conclusion rests.

The Green river itself rises many miles north of the Uinta range, traverses a relatively low basin before reaching the flank of the mountains, and then instead of turning away, it boldly enters the great uplift and trenches it from side to side in a profound cañon, flowing out to the southwest on its way to the Colorado. There is relatively low ground at the eastern end of the range, several thousand feet lower than the summits of the range on either side of the Green river cañon, and many thousand feet lower than the restored crest of the great uplift; but the river does not follow this open round-about course. Powell says that the river cut through, instead of running around, the great obstruction, because it "had the right of way; . . it was running ere the mountains were formed." Had the mountain fold been formed suddenly, it would have turned the river around it to the east; "but the emergence of the fold above the general surface of the country was little or no faster than the progress of the corrasion of the channel." . . . . . "The river preserved its level, but the mountains were lifted up. . . . . The river was the saw

* Exploration of the Colorado river of the west, Washington, 1875. 152-166. See also the geological map in the Geology of the Uinta mountains, 1876.

which cut the mountains in two" (152, 153). If this interpretation is correct, the Green river would be the type of a perfect antecedent stream: but it appears to me that the case is probably overstated in that respect. Perhaps it would have been more deliberately stated in a later volume if Powell's intention of describing more fully the three chief kinds of drainage of the region had been carried out.* Not having seen the region, my comments may have little value; but the context of Powell's report, the description of the immense series of lacustrine beds, over a mile thick, north of the mountains, and the eastward deflection of the river where it traverses the mountains all seem to me to indicate that the Green was by no means continuously successful in maintaining its antecedent course across the uplift. It is by no means a typical antecedent river. The great series of lacustrine beds up-stream from the cañon, with conglomerates where they rest on the northern flank of the mountains, are fully recognized in the report, and must mean that the upper portion of the river was for a time shut back, or ponded. During part of this time, there may have been no overflow across the growing mountains, for the lower lacustrine beds contain fossils indicative of brackish water.† The intermittent growth of the mountains and the repeated return of lacustrine conditions, with gradually freshening water, is indicated by the strong unconformities that occur at various points in the lacustrine beds, and by the change in the fossil fauna. It must be conceded from this that the upper portion of Green river was repeatedly ponded back by mountain growth across its middle course; we therefore have not now any close indication of its pre-lacustrine course above the mountains; the ancient, or pre-Uinta, upper portion of the river was extinguished by the lacustrine sediments, and to that extent the Green river departs from the perfect antecedent type.

In the second place, if the original Green river existed upon the upper surface of the beds that were at a subsequent date raised to form the Uinta uplift, it does not appear to be clearly proved that its course at that early time was closely coincident with its present course in the mountainous area. The first deformations of the mountain growth may have temporarily interrupted its flow, as is made likely by the lacustrine deposits

* Geol. Uinta mountain, page v.

† Geology of the Uinta mountains, 1876, 84; Chapter III, by C. A. White.

already referred to; and when the rise in the level of the waters of the lake overtook the uplift, probably at a time of slower mountain growth than that which first formed the lake, the point of overflow may have been many miles to one side of its previous drowned-out course. The moderate elevation of the eastern end of the range, where it connects with the Yampa plateau, may possibly have then been a little higher than a point farther west, where the overflow was consequently located. This is perhaps hardly as probable as the postulates involved in arguing a truly antecedent course for the river; but its impossibility is not as strictly proved as would be necessary before a definite conclusion as to the continuous persistence of an antecedent river could be finally accepted. Such continuity of action must be rare and should be rigorously demonstrated if possible.

It must, moreover, be remembered that Emmons* is of the opinion that the Colorado river is not antecedent at all, but is superimposed on the eastern portion of the Uinta range from a course that it had chosen upon a sheet of horizontal sediments—the Wyoming conglomerate—which he supposes once stretched unconformably all over the previously deeply eroded surface of the uplifted range, where the cañon is now cut. He quotes facts of two kinds in evidence of this; first, the remnants of the Wyoming conglomerate still lie on ridges as high as those that enclose the river cañons; second, the Green and certain of its branches possess tortuous courses, out of accord with the structure of the range. It might be added that the wide open valley of Brown's park, in the middle of the range is best explained as the product of a pre-Wyoming cycle of erosion by rivers that were extinguished when the Wyoming beds were laid over the mountains. The strongest objection to Emmons' conclusion seems to be the great amount of erosion that it requires; erosion sufficient not only to remove the Wyoming conglomerate from nearly all its former overlap on the Uinta range, where it had buried and extinguished a pre-Wyoming drainage, but also to carry away a vast extension of the formation at the same height north of the range. It may be best to conclude that both antecedent and superimposed processes must be called on: for one must hesitate before admitting that the Wyoming beds stretched all across the country north and east of the Uinta range up to the height at which the remnants are now found on the range;

* Fortieth Parallel Survey, ii, 1877, 194, 205, 206.

it seems more likely that some part of the height of these remnants is due to a relatively local elevation. As far as this is the case, it gives reason for regarding the Green as an antecedent river; that is, antecedent to the local elevation of the Wyoming beds, but long posterior to the elevation of the Uinta range: but as the river now flows—according to Emmons' theory—on beds lying unconformably below those on which its course was chosen, it is for this reason to be classed as superimposed.

The Green river therefore certainly departs from the type of an antecedent stream; the departure is distinct in its repeated ponding, whereby its upper course was broadly and indeterminately shifted from its original location; and is at least possible if not probable in its defeat at the line of uplift and subsequent superimposition on a new line of overflow. The mountains wrenched the saw that afterwards cut them in two.

A study of the Jura drainage, of which a fuller account may be given at some future time, has led to the provisional conclusion that many of its streams show a combination of consequent and antecedent characteristics. They appear to be consequent on the early stages of the deformation but antecedent to its later growth, and for this kind of a stream I have no satisfactory name to suggest at present.

Heim has shown that the Reuss and the adjacent smaller transverse streams of northern Switzerland near Lucerne are in part persistent across a series of folds, and in part slightly shifted from one course to another and ponded in Lake Lucerne; but unless the other ranges of the Alps rise hereafter faster than they have heretofore, the geologist of the future will reasonably regard the more mature Reuss as an essentially successful antecedent river.

The Sutlej and other rivers that escape from the inner valleys of the Himalaya by deep gaps in the outer ranges, are described by Medlicott as antecedent to the elevation of the ranges through which they flow: their antecedent origin being argued from the delta-like structure of the upturned beds in the outer gorges, as if the rivers were now cutting down the deformed deltas of an earlier time; but the heavy gravel and sand deposits in their upper valleys indicates that they were nearly if not quite ponded for a time during the deformation.

Rivers seem to have the habit of cutting down their upturned deltas. Bonney refers to several such examples among the rivers

that flow northward from the Alps, and transect particularly thick portions of the upturned marginal conglomerates and sandstones, which he regards as the deltas formed by the same rivers at an earlier time, when the mountain folding had not extended outward as far as it does now from the axis of the Alps. I have suspected that the same kind of evidence might be used to indicate that the Delaware above Trenton, between Pennsylvania and New Jersey, is in part of even pre-Triassic origin ; for where it now enters the Triassic belt, there is a particularly heavy and coarse sandstone, sometimes conglomeratic. Being a large stream, it might persist in an anaclinal course through the northwestward monocline formed by the Jurassic uplift of the Triassic beds, although the smaller streams of the region were then probably extinguished, to be replaced by a new system consequent upon the new order of things.

Large rivers, more or less persistent in the face of opposing disturbance, therefore appear to be generally recognized; but it is noticeable that those quoted from the Himalaya and the Alps presumably occupied, at the time of disturbance, well enclosed valleys, from which it would have been difficult for them to escape backwards or laterally; and that, even if successful in the end, they for a time suffered defeat or ponding of greater or less extent and duration. There is no evidence that the Green river was well enclosed immediately north of the Uinta mountains at the time of their first elevation; hence the likelihood of its temporary ponding or enclosure is increased.

It is stated by Powell that not only the Green but even the smaller streams of the Uintas are of origin antecedent to the mountains. He writes: "the explanation of the cañons of Green river will assist us in understanding the origin of the lateral valleys and cañons. The streams were there before the mountains were made—that is, the streams carved out the valleys and left the mountains. The direction of the streams is indisputable evidence that the elevation of the fold was so slow as not to divert the streams, although the total amount of elevation was many thousands of feet. Had the fold been lifted more rapidly than the principal streams could have cut their channels, Green river would have been turned about it, and all the smaller streams and waterways would have been cataclinal" (Colorado River, 162).

This appears to me an unproved conclusion, and the evidence of it needs careful attention. It appears that there are several streams which descend from the crest of the mountains towards the flanks, but instead of running all the way out to the margin of the fold, they turn along the strike of a monoclinal valley, and thus reach the main river by a short cut. Such streams are cataclinal for a time, then monoclinal. It is in reference to these that it is said, "the streams were there before the mountains were made;" and again that "the drainage was established antecedent to the corrugation or displacement of the beds by faulting and folding" (163). In approaching this conclusion, Powell says these streams cannot be consequent; for "valleys consequent upon the corrugation, which was one of the conditions of the origin of the Uinta mountains, could not have taken the direction observed in this system; they would have all been cataclinal, as they ran down from the mountains, and turned into synclinal valleys at the foot, forming a very different system from that which now obtains" (166). Nor can the streams be superimposed, for the "later sedimentary beds, both to the north and south, were found not to have been continuous over the mountain system, but to have been deposited in waters whose shores were limited by the lower reaches of the range" (166). Therefore the discordant streams must be antecedent.

It appears to me that the possibility of error in this argument lies in the omission of all consideration of the migration of divides and the resulting adjustment of stream courses to deep internal structure; but at the time of the exploration of the Colorado river, this important process in the development of rivers was not understood. It now seems only natural that the original, consequent, cataclinal streams, flowing down the slopes of the range from crest to flanks, should have permitted the opening of subsequent monoclinal branches on the soft beds that they discovered; and that the shifting of divides in these monoclinal valleys should have led to the capture of several cataclinal streams by that particular one of the subsequent branches that grew out from the master stream, the Green river itself. Thus it must happen that the streams "which head near the summit of the range, and, running down the flank, turn into the Green river, are, in their upper courses, cataclinal, and when they turn to follow the strike of the rocks into Green river, are monoclinal" (161): this being a normal result of river work in cutting down the thousands of

feet of rocks of various hardnesses, here concerned. The smaller streams of the Uinta range are therefore certainly not of necessity antecedent to the Uinta uplift : the probability is that they were originally purely consequent, and that at present they are nicely adjusted to the structures that they have discovered.

I have learned so much from the doctrine of baselevelling, as presented in Major Powell's writings, that I shall hope to profit by the lesson of the Uinta drainage as well : that is, the possibility that an apparently sound conclusion may be overturned when new processes that bear upon it are discovered. It is here said that the drainage of the Watchung crescent in New Jersey is an example of partial adjustment following a superimposed origin : hence the necessity of watching closely for the discovery of new principles in the history of river work that may call for a revision of this conclusion.

There are two other examples of peculiar accidents in the history of rivers in New Jersey, to which I wish to call attention ; both of them in the latest cycle of the development of the State, that is, in the cycle which has changed the central region from its even baselevelled lowland surface, to the pastplain as we now see it. Like the uplift of the Schooley (Highland) peneplain, the uplift of the Central plain, in passing from the second to the third cycle, was not uniform throughout, but was greater in one place than in another. In the neighborhood of the lower Raritan river, a distinct though gentle slope to the northwest is apparent in the unconsumed surface of the pastplain ; but this strong river runs southeastward against the slope ; it is an anaclinal stream. The tilting of the pastplain is moderate, and its rocks are weak ; the river is large and strong. Its anaclinal course is therefore best explained by regarding it as a mild example of an antecedent stream. But Ambrose's brook, a small stream to one side of the Raritan, flows northwest with the gentle slope that was given to the pastplain. Ambrose's brook therefore most likely is not a survivor from the previous cycle, but is a new stream consequent on the slight deformation by which the latest cycle here considered was ushered in. Manalapan and Assanpink are apparently of the same kind. (See fig. 1).

The Millstone river appears to be intermediate as respects origin between the Raritan and Ambrose's brook. It appears still to lie for the most part in the channel that it occupied before the elevation and tilting of the baselevelled Central plain, but the

tilting of the plain seems to have reversed its direction of flow. It rises near the center of the State and flows northwestward till it joins the Raritan near Somerville, and on the way it crosses from the thrown or depressed to the heaved or elevated side of the "fall-line,"* and passes through a deep gap in the trap ridge of Rocky Hill back of Princeton. I believe there is no other Atlantic river which runs against the fall-line in this way; and it is certainly at first sight remarkable that a stream of moderate size like the Millstone should have held its own against a displacement that sufficed to deflect great rivers like the Delaware and the Susquehanna from their courses.

The Millstone appears to have been a stream of the normal kind in the previous cycle, before the tilting of the Central plain, when it probably ran southeastward with its fellows, and carried off its share of waste in the baselevelling process of that time. No other supposition than this seems consistent with the general history of the region. It was during that cycle that the deep gap was cut in the Rocky Hill trap ridge. Then came the deformation of the baselevelled plain, the relatively recent elevation and gentle tilting that have permitted the streams to carve it into a pastplain; and with this, the dislocation along the fall-line. The inclination of the interstream surfaces of the pastplain leaves no doubt that it was tilted to the northwest, and to this tilting we must ascribe the present direction of the Millstone flow: but why did not the accompanying dislocation on the fall-line throw this moderate sized stream off of its track and divert it southwestward to the Delaware at Trenton, or northeastward to the Raritan below New Brunswick. The effect of the dislocation appears with considerable distinctness along a line from Trenton towards Amboy, in the less altitude of the general surface of the pastplain to the southeast than to the northwest of the line, the difference of altitude of the two parts being about a hundred feet. The persistence of the Millstone against such a dislocation seems to require that we should postulate a slower and smaller movement here than that which deflected the Delaware.

The reversed course of the Millstone cannot be regarded as an example of inversion following a capture of its ancient northern headwaters by a branch of the Raritan; for in such a case, surely the inversion could not have progressed farther south than the

* For an account of the "fall-line" displacement, see McGee, Seventh Ann. Rep., U. S. G. S., 1888, 616.

hard trap ridge of Rocky Hill, where a stable divide would have been formed: nor can the Millstone be regarded as an original stream, first developed and consequent upon the deformation of the Central plain, for in that case, it should consist of two separate parts; one part running from the actual head of the river to the fall-line, where it would turn southwest and cross the faint flat divide that separates it from the Delaware; the other part beginning by Princeton north of the fall-line, and running thence north to the Raritan. The continuity of these two parts in the actual Millstone seems to be explicable only by regarding the river as the upper portion of a single larger river that had reached an old age in the previous cycle; it was then broken in two at the head of the present river where the greatest elevation of the Central plain occurred, and thus had its former head waters reversed from a southeast to a northwest direction of flow across and against the fall-line break by the tilting of the plain. Only in this way can the deep gap in Rocky Hill be explained. The river is thus consequent on the tilting of the plain, and yet antecedent to the accompanying faulting. It cannot be called an original stream, for it had an ancestor in its very channel. It is not a purely consequent stream, for it runs against the heaved side of a fault. It is not a strictly antecedent stream, for it flows in a direction determined by a disturbance that occurred late in its life. It is too exceptional a stream to have a generic name. We cannot expect to find many others like it.

The result that has been of the greatest interest to me in these studies is the discovery of well-recorded and peculiar histories in the commonplace small-sized rivers of our Atlantic slope. We have looked for some years to the west as the region where river history should be illustrated, because it was there that the pioneers in this branch of study taught us the lessons on which our further work must depend. But home study as well as distant travel has its rewards, and with the progress of good topographic work on this side of the country we confidently await much instruction from a close acquaintance with the curious histories of many of our rivers which we know now only by name.

Harvard College, January, 1890.

Supplementary Note.—Professor Albrecht Penck of Vienna has published a valuable essay on "Die Bildung der Durchbruchsthäler" (Verein zur Verbreitung naturwissenschaftlicher Kennt-

nisse in Wien, 1888) from which the following historical notes are taken to illustrate the gradual overthrow of the fracture theory of cross valleys by the introduction of the idea that rivers can sometimes cut down their beds as fast as the land is uplifted or upfolded beneath them.

Ferd. Römer. Die jurassische Weserkette. Zeit. d. deutsch. geol. Gesellsch., ix, 1857, 581. The deepening of valleys by rivers and streams must keep pace with the gradual elevation of continental masses. The Porta Westphalica has thus been cut by the Weser in the Wiehen-Weser range, in the northeastern part of Westphalia.

A similar suggestion was briefly made a little later by Bischoff, to explain the gorge of the Rhine below Bingen. Lehrb. d. chem. u. phys. Geol., 2 Aufl., i, 374, 382 : and again independently for the same river by Dücker. Zeitschr. d. Gesellsch. f. Erdk. Berlin, v, 1870, 183.

Gümbel explained the course of the Altmühl, a branch of the Danube which crosses the Frankish Jura in northwestern Bavaria, by supposing its course was defined before and maintained during the deformation of the range. Bavaria : Landes- und Volkskunde des Königreichs Bayern, 1865, iii, 756.

Medlicott recognized that many streams flowing from the inner Himalaya are older than the outer ranges, and showed reason for believing that they held their places while the outer ranges were tilted up. Mem. Geol. Survey India, iii, 1865, 6, 122, 127, 157, 163. A little later, he applied the same explanation to some Alpine rivers. The Alps and the Himalayas, a geological comparison. Q. Journ. Geol. Soc., London, xiv, 1868, 47, 52.

Wynne explains the Indus and adjacent rivers as of greater age than the elevation of the Salt Range in northwestern India. Mem. Geol. Survey India, xi, 1875 ; xiv, 1878.

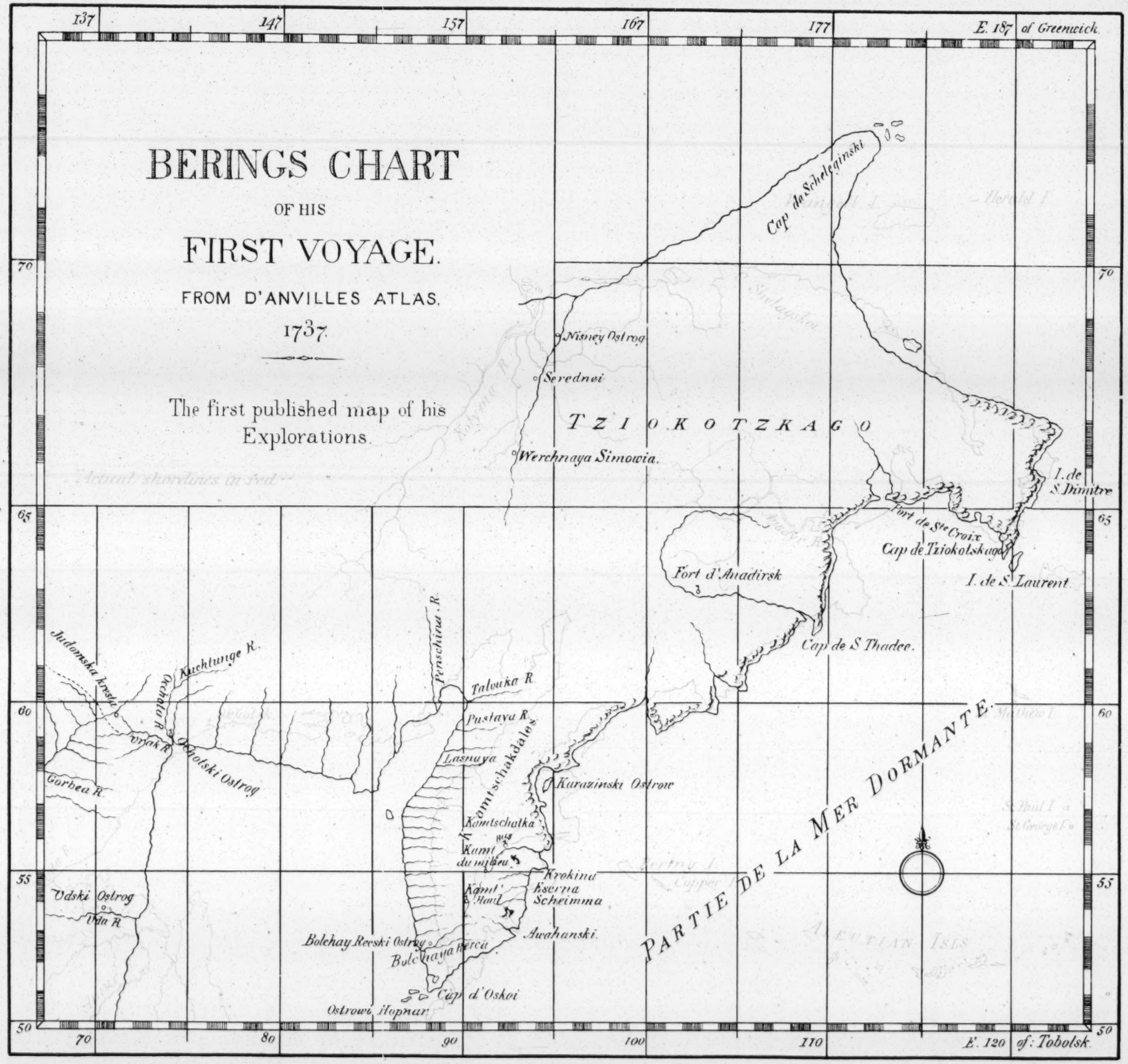
Rütimeyer recognized the possibility of uprising ranges being cut down by transverse rivers, but regarded the occurrence as a rare one, thinking that lakes would generally appear behind such a growing barrier. He emphasized the idea that erosion works upstream, which Löwl has later developed farther. Ueber Thal- und Seebildung, Basel, 1869 ; 2 Aufl., 1874.

Tietze regarded the persistence of rivers across growing ranges as the rule rather than the exception. Die Bildung von Querthälern. Jahrb. d. k. k. Geol. Reichsanst., 1878, 581.

Hayden was perhaps the first to point out in this country the antecedent origin of certain headwaters of the Missouri in Montana, where the mountain ranges are frequently cut across by deep cañons. Amer. Journ. Science, xxxiii, 1862, 305. Hayden's Sixth Report, 1872 (1873), 85.

Reference may be made also to White, Hayden's Tenth Report, 1876 (1878), 52 ; Peale, id., 167 ; Bechler, id., 372. General discussion of valley making is given by Green, Geology for students and general readers, London, 1876 ; Hartung, Zeitschr. Gesellsch. f. Erdkunde, Berlin, 1878, 308.

In spite of the early date of some of these essays, the idea of the antecedent origin of rivers did not gain general recognition and acceptance till it was strongly stated by Powell.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FROM D'ANVILLES ATLAS.
1737.
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Talouka R.
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Uda R.
PARTIE DE LA MER DORMANTE.

A CRITICAL REVIEW OF BERING'S FIRST EXPEDITION, 1725–30, TOGETHER WITH A TRANSLATION OF HIS ORIGINAL REPORT UPON IT. With a Map.

By Wm. H. Dall.

Contents. — Introductory remarks. — Instruments and Methods. — Sources of information.—Translation of Bering's Report.—Bering's List of Geographical Positions.—An Itinerary of the Expedition.—Annotated Synopsis of the Voyage compiled from all accessible data. —Comparative Table of Geographical Positions.—Resumé of the results of the Expedition.

In 1648 the tide of exploration and adventure setting eastward through Siberia, impelled the fitting out of seven small trading boats on the Kolyma river. Three of these, in charge of Simeon Deshneff, Gerasim Ankudinoff and Feodor Alexieff, respectively, reached Bering Strait. Ankudinoff's boat was wrecked on East Cape, but his party was accommodated on the others. There were hostilities with the Chukchi, the two boats were separated, and Deshneff's alone finally reached Kamchatka. Next year he constructed the trading post on the Anadyr river subsequently known as Anadyrsk.

There is a tradition that in 1654 a trader named Taras Stadukin followed Deshneff's route, made a portage across the neck of East Cape, circumnavigated Kamchatka, discovered the Kurile Islands, and finally reached the Gulf of Penjina in safety.

In 1711 an emissary named Peter Iliunsen Popoff was sent to East Cape by the Russians to induce the Chukchi to pay tribute. In this he failed, but brought back an account of islands beyond East Cape, and of a continent reported by the Chukchi to exist beyond these islands. Some statements which he made in regard to the people of this continent were regarded by geographers of the last century as fictitious, but with our better knowledge, they set the seal of authenticity upon Popoff's report and show that his journey was really made.

The political disorders which prevailed in Western Russia about this period, prevented any attention from being directed to the reports of these explorations, which were preserved in the archives at Yakutsk. Somewhat later the attention of geog-

raphers was directed toward this unknown corner of the world and the subject was brought to the notice of Peter the Great. He took great interest in it, drew up instructions for an expedition with his own hand and delivered them to Count Apraxin with orders to see them executed. A few days later, in January, 1725, he died; but the Empress desiring to carry out all the plans of her deceased husband as closely as possible, ordered their execution. Fleet-Captain Vitus Ivanovich Bering was nominated to the command of the expedition and Lieutenants Martin Spanberg* and Alexie Chirikoff to be his assistants.

This expedition forms the subject of this paper. It has been treated of by various geographers and biographers, but so far the original report of Bering, printed in 1847 in the Russian language, has never been faithfully translated into any other language; while his map has never, in its entirety, been published at all. Reduced sketches derived from the maps and more or less mutilated and garbled versions of the report have appeared in sundry collections of voyages, and upon these the latest contributions to the history of the expedition have been in great part based.

Believing that the original report is a document of sufficient historic and geographic interest to be made accessible to those who do not read Russian, and that the errors of existing works make a critical review of the subject desirable, I have translated the document in question and prepared a general review of the present state of our knowledge in regard to the expedition.

Bering's Report being written in archaic and badly spelled Russian, with a singular disregard of punctuation and other literary niceties, the translation presented unusual difficulties, in solving which I have had the kind coöperation of that excellent Russian scholar Mr. J. Curtin. I am indebted to the Reverend Father Richards, president of Georgetown University, and Father Maas of Woodstock College, Md., for valuable information in regard to the church festivals and saints, whose names were utilized in the nomenclature of Bering's new discoveries. To Mr. Marcus Baker, Messrs. Gannett and Woodward, and Mr. C. C. Darwin of the Geological Survey; Dr. S. Hertzenstein of the Zoological Museum of the Academy of Sciences, St. Petersburg; Baron Nordenskiöld of Stockholm, and Baron Robert Klinckofström; Drs. Holm and Stejneger of the U. S. National Museum, and Prof. Julius Olson of Madison, Wisconsin, I am

* So spelled by Bering himself.

indebted for numerous favors and courteous assistance, and to all of these gentlemen I desire to express my thanks.

In conclusion I desire to state that I am well aware this paper cannot be regarded as a finality, but as a contribution to the geographical history of North America it will not be without its value, while the fact that I have myself spent parts of three summers in scientific exploration of the coast visited by Bering and first charted by him, has greatly helped me in my discussion of minor details of his work.

Instruments and Methods.

In considering the work done by the expedition it is very necessary to bear in mind the character of the instrumental outfit, if any, which they might have possessed, and the state of the science of navigation at the time.

When Bering and his two cartographers left St. Petersburg in February, 1725, the astronomical instrument in use by navigators was the Davis quadrant or "backstaff," in which the sun's altitude was measured by sighting without a telescope or tube on the shadow cast by the sun from one projection of the instrument upon another, the observer's back of course, being turned to the luminary. The only alternative to this was the still older astrolabe with which the observer had to look along the two lines of his angle at the same time, and which also depended upon sights or spurs attached to a frame. The reflecting quadrant of Hadley was not invented until 1731 and telescopes were not used on the instruments of navigation until somewhat later. There were no chronometers or reliable watches or clocks for use in dividing intervals of time. Even after the Hadley quadrant came into use, time was noted by a pendulum vibrating seconds, which could not be used on ship-board.

A futile attempt had been made by means of tables of variation of the compass to determine the longitude by comparison with observed variation in the field. Results by this method approached the truth accidentally, if at all. Lunar observations were the only means of getting an approximation to the longitude except the occultations of Jupiter's satellites, both methods being impracticable on board ship, with the instruments then employed.

In 1731 the astronomer Halley proved* that at that date it was still impossible to find the longitude correctly by the moon, the

* Phil. Trans. 1731, No. 421.

lunar tables being so inaccurate that an error of several hundred miles was quite possible and an accurate determination would depend upon the respective errors of instrument, observation and the lunar tables happening to balance one another. Halley ventured to express the hope that the tables may be so amended that an error may scarce ever exceed three minutes, which would correspond to a degree and a half of longitude, amounting at the equator to a distance of a little less than one hundred miles. Messerschmidt, who preceded Bering as an explorer of Eastern Siberia, was according to Middendorf (Sib. Reise, iv. 1, p. 56) thirty-two degress out in his determination of the longitude, and the eastward extent of Asia in this region was underrated by that amount or thereabouts, on many maps.

One other means of approximating to the meridian remained, in the observation of eclipses. This from the comparative rarity of these occurrences in the case of the sun and moon, could with the imperfect instruments of those days be available but seldom. Owing to the difficulty of determining the exact time of the first and last contacts the longitudes computed by these observations were liable to quite as great inaccuracy as those computed from the lunar tables. Still an ordinary spyglass would enable an observer to note the time within a minute or two, and, if he was possessed of the local time, a simple comparison with the observed time of the eclipse in some locality where the longitude was known would give a fairly good determination, considering the instruments and methods of those days. Of the four eclipses of the moon occurring in 1728–9 two might have been observed without difficulty by Bering, one would have been invisible to him, and one might barely have been noted, but in all probability was not observed by him. In none of the published reports of the expedition is any mention made by Bering or his officers of the occurrence or observation of an eclipse, which seems very singular if by such an observation he was enabled to correct an error of 30° in the longitude of northeastern Siberia. However, Middendorf states (Sib. Reise, iv. 1, p. 56) that "Bering and his lieutenant in the years 1728 and 1729 observed in Kamchatka* two eclipses of the moon," by which they corrected the longitude. He gives no authority for this statement.

* It is possible that an eclipse observed at Ilimsk in Middle Siberia by Chirikoff is thus erroneously referred to.

Euler, who had access to the archives of the Admiralty College, while engaged on a Geography of Russia, mentions (Philos. Trans., No. 482, p. 421) that he was informed that Bering observed an eclipse "at Kamchatka." This letter of Euler's is copied by Campbell in Harris' Voyages (vol. II, Book III, p. 1024) and the expression "at Kamchatka" has led to the statement that these observations were made at the fort or village of Lower Kamchatka. This is an error since Bering gives no longitude for the fort in his table of geographical positions. It must be remembered that the name Kamchatka at that period was applied not merely to the peninsula as at present, but also to the whole region of northeastern Siberia, the governor of Kamchatka being located at Okhotsk. So to come within the probable meaning of the phrases used by Middendorf and Euler it is only necessary to suppose that the observations were made somewhere in that region. Lauridsen (Danish edition, note 34, p. 186) refers to a paper of Struve (Bull. phys.-math. Acad. St. Petersb., I, 1842, p. 290) containing a table of geographical positions in Russia, in connection with these alleged observations of Bering. An examination of Struve's paper does not bear out the implication of Lauridsen's reference, as Struve not only makes no mention whatever of Bering's observations there but specifically states that the first observations of precision made in this part of Siberia were those of Krassilnikoff who accompanied Bering's second expedition in 1741. It would seem extraordinary that a determination so important for geography as that of Bering and his companion should be unknown to so distinguished an astronomer as Struve who must have had access to all the archives of the early explorations by Russia. But it may be perhaps accounted for by the facts that Bering's observations were necessarily of a very rough and primitive character—as it is certain he had no instruments of precision ; and that, for that reason, they were not received with entire confidence ; so that Struve may have considered them insufficiently exact to be included with those of Krassilnikoff and others made with more modern appliances.

From the note in regard to the eclipses which is kindly contributed by Mr. Marcus Baker and from the other circumstances, it is evident that if Bering and his party made the observations alluded to, the eclipses noted were the partial eclipse of Feb. 25 (local calendar), 1728, of which he might have observed the last contact, or the total eclipse of Feb. 14, 1729, of which he might

have observed the first contact and the totality. At the time of the last eclipse he was at Lower Kamchatka post, and as, in the list of positions handed in with his Report in 1730, no longitude is entered for this locality, it would seem that choice is reduced to the first of the two mentioned; which occurred when Bering was either at Bolsheretsk or on his way from that place to Lower Kamchatka, which he reached about a month later. Campbell's table of positions is credited by him to the year 1728, but my own opinion is that it was really derived (with various errors, interpolations, etc.) from Bering's table of 1730.

The ordinary method of getting the longitude of a place, and that upon which Bering originally depended, as his itinerary table shows, was by a continuous record of the distances and directions traveled from a point of known longitude. This record would afford the data from which the distance on a mean parallel, by means of a traverse table, could be computed. Laborious, imperfect, and slow as it was, it was the only sure reliance of the traveler in those days. Whether Bering observed an eclipse or not, it is certain that his original dependence was upon his itinerary, that his report was based upon that and that this part of his work was done as well as the nature of the method would permit. His silence about the eclipse may be due to the fact that he depended not upon astronomical but upon pedometric observations, to which the eclipse may have afforded some corrections. At any rate the pedometric determination of the distance between Tobolsk and Okhotsk or the peninsula of Kamchatka was in itself a tremendous undertaking.

I find by a rough calculation from Bering's data that the longitude resulting from his itinerary from Tobolsk to Okhotsk is 77° 36′ E. The distance in a straight line is about 2,390 miles, but by the route Bering traveled the distance is a little more than 3,746 miles. The longitude in Bering's List of Positions is 76° 07′, which differs from the pedometric measurement by 1° 29′ (or about 45 miles). On Bering's map, Okhotsk is located in longitude 74° 30′ E. of Tobolsk, while the most modern observations for Okhotsk put it in 142° 40′ E. of Greenwich or 75° 40′ E. of Tobolsk. So that Bering's pedometric measurement was nearly 60 miles in excess; his revised table (as corrected by the eclipse ?) 27 miles in excess; and his map about 30 miles in error in the opposite direction. These discrepancies show the inexactness of the methods then in vogue and also that the pedometric

method was not very much worse than the others in its results. Although there are several typographic or other errors in his table of itinerary which render exact comparisons impossible, it may be said that the error of the pedometric method, including the passage by sea from Okhotsk to Kamchatka, averages about two degrees or sixty geographical miles. In the cases of Okhotsk and Bolsheretsk the error is one of excess; in the case of the cape at the mouth of the Kamchatka river and of the turning point of the expedition north of Bering Strait, the result is too small by about the same amount.

That his chart and his revised list of positions should differ as they do, is quite as likely the result of the careless way in which the minutiæ of such work were generally regarded at that day, as to any difference of date, or of intentional modification.

To conclude our review of the instrumental means and methods then in use, it may be said that the compasses in use at that day were comparatively roughly made and more or less inaccurate. The variation was determined in a given latitude by the azimuth of the Polestar or the sun at setting observed by means of sights attached to the rim of the compass, which was a method accurate enough for the general purposes of navigation. The distance run was measured on shipboard by the log which was in about the same form and perfection as at present, being a very ancient invention.

The survey of a general coast-line was made by compass bearings on prominent points, repeated from successive stations, the distances of the ship's course being determined by the log and the courses by compass, with corrections for current and the variation. The lines thus obtained were checked by latitude observations made with Davis' backstaff when the weather permitted.

Apart from any of the methods mentioned it seems to have been overlooked that Bering might have corrected the longitudes of the N.E. Siberian coast by the ordinary dead reckoning kept on board his vessel, provided he started by adopting the longitude for the southern part of Kamchatka peninsula which was in common use on many of the charts of his day. Though it is true that the maps of that part of Siberia north and northeast from the Okhotsk sea were many degrees in error in the longitude, this observation does not hold good in regard to the southern end of Kamchatka. The work of the Jesuit fathers in China had already determined fairly well the position of China and Korea,

while rude outlines of the northern islands of Japan, Sakhalin, the Kuriles and the south end of Kamchatka, were added to these on maps of Asia. The outlines are often very incorrect but it is quite evident what is intended. In nearly all early maps of this region which I have been able to consult, as for instance those of N. de Witt, I have found the south end of Kamchatka in approximately correct longitude. For instance, in the Novissimae Ephemerides of Manfredio, published at Bonn the same year that Bering left St. Petersburg, and which might well have been sent to him before he sailed, we find two charts of the paths of solar eclipses (Plates ii and iii). On these charts the meridian of 180° from Ferro passes across what is unmistakably the south end of Kamchatka, though northeastern Siberia remains a blank. This would be a sufficient starting point and is quite as correct as Bering's determinations; in fact is within a few miles of the modern longitudes for the same part of the peninsula. Dead reckoning along the shores of the peninsula, corrected by latitude observations, would have done all that was necessary to correct the meridian without observing any lunar eclipse, provided the surveyor started with such an assumption as Manfredio's or De Witt's charts supply.

Sources of Information.

The general History of China [etc.] Done from the French of P[ere]. DuHalde [by R. Brookes]. London, John Watts, 1736. 4 vols. 8° with maps and ills.

This is referred to in the following text by the letter B.

This is the first English translation from the original French edition of the "Description géographique et historique de l'empire de la Chine" by the father J. B. Du Halde, published at the Hague in the same year as the above translation. The text of the original French I have not been able to consult, though, so far as Bering's voyage is concerned, there does not seem to have been any material abridgment in the translation above cited, for an opportunity of consulting which I am indebted to the Librarian of Congress.

The maps and charts of the original French edition were separately printed in an atlas by themselves, for the use of those who might desire to do without the text, under the following title:

Nouvel Atlas de la Chine, de la Tartarie Chinoise, et du Thibet: contenant Les Chartes générales & particulieres de ces Pays, ainsi que la Carte du Royaume de Corée; (etc.): Rédigées par

M^r D'Anville, Géographe ordinaire de sa Majesté très Chrétienne, Précedé d'une description de la Boucharie, Par un Officier Suedois que a fait quelque sejour dans ce Pays. A la Haye, chez Henri Scheurleer MDCCXXXVII. Folio, 12 pp. 42 charts.

The chart of Bering forms sheet 42, and differs from the others in being on Mercator's projection which indicates that it was copied directly from an original as stated in the text, and not redrawn. It is 20¾ by 9⅜ inches on the neat-lines and is entitled:

"Carte des Pays traversé par le Cap^ne. Beerings depuis la ville de Tobolsk jusqu'a Kamtschatka."

Beneath the title is a table of four transliterated Russian terms for fort, post, village and convent, with their French equivalents. This and certain peculiarities in the transliteration of proper names make it certain that the original chart was in Russian and that the transliteration was done by some one not perfectly familiar with both languages. There are a few errors of the engraver in rendering single letters "c" appearing for "t" and "r" for "e" in a few places. The longitude is reckoned in degrees east from Tobolsk to which 67° degrees when added will give practically the meridian east from Greenwich. The transcriber of the map from the Russian appears to have been a Dane, G. Kondet.

That part of this chart east from 112° E. Gr. has been fairly reproduced by Lauridsen (Chart I) with the omission of some unimportant names and the addition of a signature (not the ordinary autograph) of Bering. This is reproduced with a different running headline to accompany Olson's translation.

The fourth volume of Brookes' translation (pp. 429–440) contains

"A succinct narrative of Captain Beerings's Travels into Siberia:"

with a reduction of the above-mentioned map, on which there is no trace of the island of St. Demetrius, even its name, which alone appears on the Du Halde map, is here omitted. Otherwise this version of the map does not differ from Du Halde's, more than one copy of a drawing usually differs from another. When Bering started on his expedition he was accompanied by two cartographers (Bergh, First Voy. of the Russ. pp. 2–5, fide Lauridsen) Luzhin and Potiloff, and to one or both of them under Bering's direction the construction of the map in question was probably due.

When Bering made his report it was accompanied by a list of positions for important places visited by the Expedition.

Dr. Campbell, while gathering material for his second edition of Harris' Voyages, procured a copy of this unpublished list of positions and prints it in his account of Bering's travels, with the comment that

it was sent by Bering from Kamchatka, before his return to Russia, and to the Senate at St. Petersburg, to which Bering did not report. Whether due to the transcriber or the printer there are several very obvious errors in the list as printed by Campbell, and when it is compared with Bering's own list we see that there are also several interpolations.

But the positions adopted in the chart, said by Du Halde to have been brought to St. Petersburg by Bering on his return (a statement confirmed by the mention of a chart in the report itself), are not identical with the positions enumerated in the list. This leads to the suspicion that Bering's first chart was not published, and that the chart issued was due to a recomputation and revision of his data. This suspicion is made stronger by the statement of Lauridsen, who gives no authority, however, that Bering's chart was made in Moscow in 1731,* though this may merely mean that some of the copies which were distributed to various personages were so prepared.

These manuscript copies of the chart and report were sent to various foreign courts, as a matter of general interest, by the Russian authorities. The copy used by Du Halde was communicated to him by the King of Poland who had received it as a "Present worthy of his regard and curiosity" (Du Halde, iv, p. 439, Brookes' ed.). Other copies were sent to Sweden and probably to England and other countries. In the journal, "Ymer," of the Swedish Society for Anthropology and Geography (1884, p. 93) is a short notice by E. Dahlgren of three manuscript copies of Bering's chart of his first expedition, or rather of charts embodying its results. Two of these charts are in the Royal archives of Sweden and measures 58 × 135 cm. One of them is ornamented with ten colored drawings of natives of Siberia. The other is without these but does not seem to be a copy of the first as it has a number of soundings between St. Lawrence and the Diomede Islands which are not on the former, and some names which are peculiar to it. Both have many more names than are given on the chart published by Du Halde. Both of the manuscripts have a legend referring to the coast from the Kolyma eastward, on the north coast of Siberia, to the effect that it is put down from older charts and information, doubtless furnished by the archives at Yakutsk. The third copy is in the possession of Baron Robert Klinckofström, of Stafsund, Sweden.

Through the kind offices of Baron Nordenskiöld and the generosity of Baron Klinckofström, the last mentioned chart has been forwarded to the writer through the Smithsonian Institution for examination. It appears to be essentially the same as the second of the two charts referred to as comprised in the Royal Swedish Archives. The result of my examination of it leads me to the belief that there were two different charts sent out in manuscript by the Russian authorities. The first, which I regard as the earlier, and which is certainly more accurate, shows the island of St. Demetrius in its proper place in accordance with Bering's Report and list of positions. It formed the basis of

* Lauridsen, Am. ed., p. 57.

Campbell's engraving which will be referred to later, and of the chart which appears in the various editions of Du Halde. It is possible that this represents the original chart prepared by Bering in Kamchatka during the winter of 1728–9. The second and probably later form of the chart is represented by the Klinckofström chart, upon which the name and island of St. Demetrius have vanished and a smaller island in the corresponding latitude is represented close to the Siberian coast and westward from the meridian passing through the eastern extreme of East Cape. This island is named the island of St. Diomede. If it is intended as a revised position for the island of St. Demetrius of the other chart and of Bering's Report, it is in conflict with the facts and with the position assigned to St. Demetrius in the report. No one who had sailed between St. Demetrius and East Cape could have sanctioned such a position for the island with honesty. If a different island is intended the question arises, Why is St. Demetrius omitted? This second chart is obviousiy the basis upon which in D'Anville's chart of Asia (1753) the configuration of the eastern extreme of Siberia is based, and I suspect that the chart of the Imperial Academy of Sciences at St. Petersburg and the reproduction of Jefferys, were also derived from it as far as this region is concerned.

It would be rash, in the absence of authentic information which only the Russian archives can supply, to hazard an opinion as to the origin of the important difference between these charts. I may return to this point later. Apart from this, it may be added that the northern coast of Siberia from East Cape west to Cape Shelagskoi is represented as mountainous throughout its extent. A legend states that it is laid down from older charts and information. This relieves Bering from the responsibility for the fictitious or at least grossly erroneous and exaggerated form and direction given to Cape Shelagskoi on his chart. The west coast of the Okhotsk sea and part of its northeastern shores not visited by Bering are stated to be laid down from "information." This map is not dated and the blank space in the title left for Bering's autograph has never been filled. No name of draughtsman or place or authority of issue are indicated upon it. It measures 51 by 20½ inches between the neat-lines. It is in black and white, the mountains washed in, the only color being small green trees as a conventional sign for wooded country. A copy of the earlier chart fell into the hands of Dr. Campbell and was published by him in his edition of Harris' Voyages,* together with a version of the report which is more or less mutilated and to which the editor to make his book more readable has

* HARRIS, JOHN. Complete collection of Voyages and travels [etc.]. London, T. Woodward [and others] 1748. 2 v. folio, maps and plates, Vol. 2, pp. 1016–1041, is devoted to a discussion of Bering's discoveries, entitled: Book III, Section VIII. "A distinct account of part of the northeast frontier of the Russian Empire, commonly called the country of Kamschatka or Kamschatska including the voyages of Captain Behring for discovering toward the East [etc.], collected from the best authorities both printed and manuscript."

added certain flowers of rhetoric which detract from its accuracy. Campbell's copy of the map is the most perfect yet published and the only one showing the island of St. Demetrius in its proper place.

In Du Halde's copy and those derived from it the eastern border of the chart has cut off the island, though in some of them, as in that of 1736, the name remains. The only fault to be noted in Campbell's edition of Bering's map is the omission by the engraver of the small bay named Preobrazhenia by Bering and which, though it is not named, appears on the other editions of the map. The title is as follows :

"An exact chart of all the countries through which Capt. Behring travelled, from Tobolski Capital of Siberia to the country of Kamtschatka."

The size of the map is 7 × 12¾ inches. It extends on the east to the meridian of 126° east from Tobolsk which enables the "Isle of St. Demetrius" (our present Big Diomede) to appear in its proper place. The editions previously reported have all stopped at the 124th meridian, thus cutting off the island, whose name sometimes appeared and sometimes did not.

It will be observed that Dr. Campbell in this paper was the means of introducing the erroneous and obnoxious Germanized spelling of Bering's name into English literature. This is a pretty good indication that he had no autographic documents from Bering himself, and that his manuscripts were obtained from German sources, or at least had been transcribed into the German language. In his thorough search of the literature of the subject and lengthy discussion of the results, Dr. Campbell undoubtedly gathered the fullest account of the first expedition which had up to that date been printed. In order to enliven his history of the proceedings, the good Doctor occasionally rises to flights of fancy, and the theories he held were long since proved erroneous.

There are several other English translations of Du Halde's China, of which the following is the most important :

"A description of the empire of China and Chinese-Tartary, together with the kingdoms of Korea, and Tibet : containing the geography and history (natural as well as civil) of those countries. From the French of P. J. B. Du Halde, Jesuit. Illustrated with general and particular maps, and adorned with a great number of cuts. With notes geographical, historical and critical, and other improvements, particularly in the maps, by the Translator." London, Edward Cave, 1741. 2 vols. folio, maps and ills.

This edition does not show the name of the translator, but he was evidently a man of no small attainments as a geographer and cartographer, and introduced numerous improvements and corrections into the charts of D'Anville, which accompanied the original edition of Du-

Halde. A copy of this was presented to the library of Harvard College by the province of New Hampshire in 1765–6; for an opportunity of examining which I am indebted to the courtesy of Mr. Justin Winsor, the Librarian.

The text of this edition, compared with that of 1736, is as much as possible abridged, yet contains nothing not in the original, but the map exhibits certain additions to be noted. This map is entitled,

"A Map of Capt. Beerings' travels from Tobolskoy to Kamchatka between ye years 1725 and 1730. With improvements by ye Editor." It contains the following note by the editor. "Capt. Beerings probably obsery'd ye Lat.^d^ in ye Principal places thro' wch he pass'd, tho' two Observations only are mentioned in his Journal. But Mr Kyrilow in his Map of the Russian Empire does not follow ye Author in this respect for instance he places Ilimski 1° 30′ more north, Yakutskoy 2° more south, and Cape Chiokotskago 1° more south than Capt. Beerings; likewise other places in Proportion. I have reckon'd ye Long^d^ of Tobolskoy from Paris according to an Eclipse of ye Sun observed at Hamburg and Tobolskoy, mentioned by Mr. Strahlenberg in his account of ye Northern parts of Europe and Asia. This is all that can be done till ye return of ye Russian Mathematicians sent to make observations and discoveries throughout Siberia." Then follows a line "Inscribed to Francis Gashrey Esqr."

The main body of the chart is that of Du Halde's original and the scale is the same, but the height of the neat-lines is only 8⅝ inches. Bering's track from Okhotsk to Bolsheretsk, across Kamchatka, northward to 67° 18′; also his track eastward from Kamchatka in 1729 and around the peninsula to Bolsheretsk and Okhotsk; are indicated by dotted lines. The two latitudes noted in Bering's journal are indicated on this map by a +, and the northern one is placed near the Asiatic coast in latitude 118° E. from Tobolsk. At the top of the map the supposed Paris meridians* are indicated, a difference between Paris and Tobolsk being assumed of 70° degrees, which is about five degrees too much. There are also sundry infelicities in the transliteration of the names from the French of D'Anville.

A chart which deserves notice, though almost wholly fictitious, being chiefly devoted to the spurious discoveries of the alleged Admiral de Fonte, was issued by J. N. de L'Isle with the concurrence of M. P. Buache, or at his suggestion. It appeared at Paris, in 1752, and was copied for Jefferys' (2d) edition of Voyages from Asia to America in 1764. I do not know if this copy appeared in the first edition, but presume it did.

*In the Campbell map these are taken as east from London with an allowance of 67° between London and Tobolsk.

For present purposes the interesting features of this map are as follows:

Opposite the eastern extreme of the Chukchi peninsula there is represented part of America with the legend, "Terres vues par Mr. Spanberg in 1728, frequentées à présent par les Russes, qui en apportent de très belles fourrures." In the English edition the legend is "Seen by Spanberg 1728." Four islands are represented in the strait between Asia and America, corresponding in a general way to the four now known to exist there. Connected with America and north of the Chukchi peninsula is land with an island off it corresponding not badly to Wrangell and Herald Islands, and marked "Discovered in 1722." It is possible that this land is a hypothetical compound of the land reported by the Chukchis east of the strait with that which they knew to be visible in clear weather from Cape Yakan. more or less confused accounts of which had long been current among persons interested in these regions.

The next chart of note in this connection was published by D'Anville, the royal geographer of France, who had previously prepared the original map of Bering for publication. He issued a general map of Asia, in three parts, each of two leaves which could be joined together, of which the first part appeared in 1751 and the third part in 1753, entitled:

Troisième Partie de la Carte d'Asie, contenant La Sibérie et quelques autres parties de la Tartarie, Publiée sous les Auspices de Monseigneur Louis-Philippe d'Orléans Duc d'Orléans Premier Prince du Sang. Par le S^r. d'Anville, Sécrétaire de Son Alt^s. Sereniss^s. MDCCLIII. Avec Privilége.

This map is in two sheets (each 20 × 21 inches), the engraving of the geographical part by Guill. de la Haye and of the ornamental title by De Lafosse. The longitude is reckoned from Ferro, and the map is constructed on a scale of 23 French leagues to 60 geographical miles. The boundaries are colored and the sea shore shaded with short horizontal lines. It is on the polyconic projection.

This map includes many of the additions to geography in eastern Siberia which were due to the members of the great Siberian expedition. The courses and branches of the rivers especially were augmented and corrected as well as named. The branches of the Anadyr River were represented and named, but as no new information in regard to the coast had been received at that date, this river was still mapped as entering the sea to the south and west of Cape Thaddeus, as erroneously laid down by Bering, who confounded with the Anadyr a small river which does come in here, and passed the estuary of the true Anadyr without seeing it. The coast lines are essentially those of Bering. Beyond the basins of the Kolyma and Anadyr is marked "Terre inconnue"; a small supplement in the north-east corner of the map, on half the scale of the map, represents the north-east extreme of Asia as delineated by Bering. This little supplement is of considerable interest as it gives fuller information than that which appears on the

original publication of Du Halde, perhaps from a more modern version of Bering's chart, as previously suggested.

Several names appear for the first time in cartographic history, upon this map. Preobrazhenia Bay; Bolshoia River falling into Holy Cross Bay, and the "Isle de St. Diomide" are among these. The Island of St. Demetrius is omitted, as well as its name. The Island of St. Diomide is placed about on a line between East Cape and Cape Chukotski, to the westward of the meridian of East Cape. There is a discrepancy averaging about five minutes in latitude and longitude between the positions on this map and those on the second version of the Bering manuscript charts. But in the main these differences are, I suspect, merely due to carelessness in copying, and the general harmony between the two leads to the belief that the D'Anville outline for this region was based on the second version of the manuscript.

The differences of position for points on this part of the coast are numerous. I have noted them in the comparative table of positions herewith. They may be chiefly owing to slips in transferring from the Mercator to the Polyconic projection; but some of them are due to new information, probably derived from the surveyors of the second expedition. Bering island appears on the map, in about its proper place, though Copper island is not indicated, nor are any of the Aleutians shown. I suspect this is the first publication of a cartographic kind on which Bering island is laid down, as the map of the Imperial Academy of Sciences, embodying the geographical results of Bering's Voyage to the coast of America, was not engraved until a year later, while De L'Isle's of 1752 does not contain them.

The island between Cape Shelaginski and East Cape off the northern coast, on Bering's map, is omitted by D'Anville. The Kamchatkan peninsula in latitude 56° is represented to have a width of 180 miles, while Bering made it 270 miles.

A most important contribution to the subject appeared in Müller's Historical Collections known as the "Sammlung Russische Geschichte" and published at St. Petersburg (Kayserl. Academie der Wissenschaften, 1732–64. 8°. Nine volumes.) Des dritten Bandes (erstes, zweytes und drittes Stück, pp. 1-304, 1758) contains the original account of the Russian Voyages toward America from which the work of Jefferys has, with some errors and omissions, been translated. As far as regards Bering's first voyage, there is only one error of consequence made by Jefferys, which will be noted in its place. This book is extremely rare, and the only copy in America which I have been able to find after much enquiry, is in the library of the Smithsonian Institution.

The first volume of this series has the title

"Eröffnung eines Vorschlages zu Verbesserung der Russischen Historie Durch den Druck eines Stückweise herauszugebenden Sammelungen von allerly zu den Umstanden und Begebenheiten dieses Reichs gehorigen Nachrichten. St. Petersburg, bey der Keyserl. Academie der Wissenschaften, 1732."

The succeeding volumes have the running title "Sammlung Russische Geschichte" with the number of the parts subjoined but no other title-page.

The account of the Russian Voyages is stated by Müller to have been prepared at the direction of the Empress and endorsed by the Academy of Sciences. It contains invaluable material on the early explorations, which, if it had not been for Müller's painstaking researches, would have been totally lost, as the archives of Yakutsk from whence the data were derived by Müller were subsequently destroyed by fire. The errors which occur in it are chiefly due to Müller's endeavor to utilize the inexact geographical data of the Promyschleniks and Cossacks by combining them with the less detailed but more precise observations of later observers. In this attempt he added many valuable details to the charts, but at the same time introduced several errors. The exaggerated distances reported by the first explorers who were unable to correct their estimates by observations of precision, distort those parts of the map due to their reports. The peninsula of Aliaska becomes hugely exaggerated as does the Shelagskoi promontory on the Arctic Sea. But no unprejudiced person can read Müller's account without perceiving his great caution in accepting unreservedly these imperfect contributions, the really important additions which he made to cartography, the preciousness of the facts which he rescued from oblivion, and his desire to be fair to everybody.

The insinuations of malice and of a desire to injure Bering by means of this account given by Müller, which Lauridsen attributes to the latter, appear to be entirely the product of a suspicious temperament and an excited imagination. Certainly I have seen nothing anywhere cited which lends to such suspicions any tint of probability. The facts cited in support of them can easily be otherwise explained, if one desires to view the subject judicially, and for the most part are not quite thoroughly understood by the Danish author.

One error upon which the latter lays great stress, is due to a manipulation of the record, originated or at least adopted by Bering himself, and which is incorporated in the map and report which all authors agree proceeded directly from Bering's own hand.

The next map of importance was issued by the Imperial Academy of Sciences, St. Petersburg in 1754. It was made under the inspection of Gerhard Friedrich, Staatsrath von Müller, who revised and corrected it subsequently, when an edition dated 1758 was issued. This map comprised the geographical results of the great Siberian expedition sent out by the Russian government; of Bering's voyages; and of the records of the hunters (Promishleniks) and traders in northeastern Siberia preserved in the archives of Yakutsk. The sources of this map are fully explained by Müller in the "Russian Discoveries" (Jefferys' translation, p. 108 et seq.). I have not been able to examine a copy of the original map, and have therefore relied on the English version of it which is to be found in Jefferys' translation, second edition, London, 1764.

XUM

Among the improvements introduced on this map may be specified, the correction of the shores of the Okhotsk Sea, and Gulf of Penjina, the correcter location of the mouth of the Anadyr river and its estuary, the introduction of the results of the voyages of Gvosdeff, Bering and Chirikoff to the northwest coast of America, and a multitude of details relating to northeastern Siberia. The island of St. Deomid (Diomede) is not represented though its name appears on the 65th parallel in Bering Strait. The island may have been on the original map and carelessly omitted by Jefferys' engraver on his copy. Among the errors, or rather mistaken hypotheses of others, which are suggested in this map by dotted lines, are the extension westward to 174° E. of Greenwich, of the peninsula of Aliaska which is also given a wholly uncalled-for width; and the northward extension of the coast on each side of Bering Strait. In the former case the cartographer was misled by the errors of the map of Bering and Chirikoff's last voyage and rumors reported by other navigators; and in the second case he followed Bering in adopting an erroneous position and exaggerated form for the coast eastward from Koliuchin Bay, due to the uncorrected sketches of the Cossacks and traders. The northern extension of the American coast opposite, was purely hypothetical and for this Müller must be held responsible. Many of the western Aleutians are exaggerated in size and erroneous in position but the chart of Bering's last voyage, and the exaggerated reports of the hunters who followed him, must be held responsible for this, in the main.

The work in which this chart appears is largely derived from Müller's "Sammlung russische geschichte," St. Peterburg, 1758, vol. iii, Parts I–III (cf. antea). The first edition is entitled, according to bibliographies:

"Voyages from Asia to America for completing the discoveries of the northwest coast of America. A summary of voyages made by the Russians on the frozen sea. From the high Dutch of S[taatsrath]. Muller by T. Jefferys. London: T. Jefferys, 1761." lxvi, 76 pp. 4°, with four maps.

The second edition which is that referred to in this paper is entitled

"Voyages from Asia to America, for completing the discoveries of the northwest coast of America. To which is prefixed, a summary of the Voyages made by the Russians on the Frozen Sea, in search of a northeast passage. Serving as an explanation of a map of the Russian discoveries, published by the Academy of Sciences at Petersburgh, [etc.] London: T. Jefferys, 1764," viii, 120 pp. 4°, four maps.

A French translation by Dumas, with the author's initials misprinted G. P. instead of G. F., was printed at Amsterdam in 1766. It consisted of two volumes, 18mo, with a map. A Danish translation, by Morten

Hallager, was issued at Copenhagen in 1784, as a portion of a volume relating to northern explorations. Bibliographers seem to have been puzzled by the discrepancy of initials, not recognizing that the S. in Jeffery's volume stood for a title and not a name. Another work important in its collection of facts bearing upon the general question of the explorations eastward by the Russians, was published by the archdeacon of Wilts, Rev. William Coxe in 1780. This was followed by a second edition during the same year. A third edition accompanied by a Supplement of 57 pages was printed in 1787 and a fourth in 1803. There were two apparently distinct translations of the book printed at Paris in 1781, and a German edition at Frankfurt and Leipzig in 1783. The third edition which is the best and most correct appeared both in octavo and quarto form, and is that to which reference is made in this paper. It is entitled:

"Account of the Russian discoveries between Asia and America. To which are added the Conquest of Siberia, and the history of the transactions and commerce between Russia and China, [etc.]. London: T. Cadell, 1787."

410 pp. 8° [or 4°] with four charts and one plate; to which is added, consecutively paged:

"A comparative view of the Russian discoveries with those made by Captains Cook and Clerke, and a sketch of what remains to be ascertained by future navigators. London: T. Cadell, 1787." 3 l. unp., 417–456 pp. 8°.

The latter was also separately issued. Among the maps contained in this work of Coxe's are a reduced copy of the general map of Russia issued by the Imperial Academy of Sciences, St. Petersburg, 1776, and a chart of Synd's Voyage toward Chukotski Noss.

The latter is the only chart of Synd's voyage (1764–1768) which is accessible, and it is vouched for as authentic by Dr. Coxe. Compared with later charts it is, of course, extremely imperfect yet there is in it enough resemblance to the truth to enable us to recognize what was intended in many instances. In the northeastern part of the chart, the latitudes are exaggerated and the longitudes contracted in a very erroneous manner. Nevertheless we recognize East Cape, here named "Prom. Tschukotskoi;" the two islands now called the Diomedes but here left nameless; a large island, moved eastward out of place, but doubtless intended for Arakam Island, is called "I. Diomedis;" while among a crowd of islets (referable to the hills of St. Lawrence Island seen through a fog and laid down very inaccurately), the name "S. Diomedis" appears again. The American coast was seen and landed upon; Cape Prince of Wales and the shore south and east from it are recognizable. The island of St. Mathew was discovered and named, though placed a degree too far south. The island of St. Paul in the

Pribiloff group was discovered by Synd, put in its true latitude, and named Preobrazhenia or Transfiguration Island. It is about seven degrees out in relative longitude and fourteen in absolute longitude. One cannot doubt however that it was the island now known as St. Paul when we recall the fact that there are no other islands than the Pribiloff group, in that latitude or within that general area of Bering Sea. The southern Cape of the Chukchi Peninsula, Chukotski Cape of Bering and Müller is represented two degrees too far south. Preobrazhenia Bay is not recognizable but the name is transferred to the bight west and north of Cape Bering of our present charts. This part of the coast was not however approached by Synd, who spent much time on the coast of Kamchatka. On his chart this peninsula is represented better than we should have expected from the rudeness of the rest.

The map of the Academy shows the influence of those who discredited the near approach of America to eastern Siberia; notwithstanding the explorations of Deshneff, Gvosdeff and Synd, the American shore of Bering Strait has disappeared altogether. The eastern portion of the Chukchi Peninsula is indented by a host of hypothetical inlets, and defended by an unrecognizable archipelago of nameless islands. The far-stretching chain of islands, among which Bering's second expedition was so long entangled, excepting those confirmed by Krenitzen and Levasheff (who sailed far north of the southern arc of the chain) is also absent. Excepting that the fictitious peninsula north from Chukchi land is effaced, the map in its main features for this region is less accurate than that of Bering, and does not compare very favorably with that of Müller. And yet but shortly after its publication, the explorations of Cook and Clerke recorded the facts which should, when published, exalt the memory of the older geographers and scatter the hypotheses which for a time prevailed against them.

Their explorations are included in

"A voyage to the Pacific Ocean, undertaken by the command of his Majesty, for making discoveries in the northern hemisphere, [etc.], performed under the direction of captains Cook, Clerke and Gore, in his Majesty's ships the Resolution and Discovery, in the years 1776–1780. London, for T. Nicol and T. Cadell, 1784–5." 3 volumes 4° and atlas folio."

This is the edition ordered by the Admiralty. Of this celebrated work, said to have been written from the explorers' manuscripts by Bishop Douglas, there have been many editions. In the Bulletin of the Société de Géographie, Paris, 1879, pp. 481–540, is a bibliography by James Jackson.

The most interesting points in regard to Cook's explorations about Bering Strait are comprised on the chart (vol. ii, p. 467) entitled:

"Chart of Norton Sound and of Bherings Strait made by the East Cape of Asia and the west point of America."

On this chart the main features of the coast on either side of the strait are correctly indicated, though several of the inlets and bays are wanting. The Diomedes and Fairway Rock of modern charts are located but left without names, King's Island is named; Arakam was not recognized as an island nor was Point Chaplin (Indian Point) observed. St. Lawrence Island was seen in foggy weather. Its isolated hills connected by very low flat land led Cook into the error of supposing that it comprised several islands, one of which he correctly referred to that named St. Lawrence by Bering and the rest he lumped under the name of Clerke's Islands. A single fictitious island, midway between St. Lawrence and King's appears on the chart, but is not named or mentioned in the text. St. Lawrence Bay is named and discovered. Bering and Müller's Chukotski cape is correctly identified. East Cape is well delineated, and the name Serdze Kamen (Heart-Rock) originally given to a cliff or bluff point at the entrance of Holy Cross Bay is transferred to a point on the Arctic shore of the peninsula. There is a confused and somewhat curious history connected with the use of the names Serdze-Kamen and Chukotski Cape. After the travels of Deshneff, Popoff and others and the reception at various times of information from the natives, it was pretty generally understood among the hunters and traders of this region that the extreme of Asia was a cape or point on or near which the Chukchi dwelt, or which they described, which was not definitely located, and which was vaguely known as the Chukchi Cape or the Cape of the Chukchis, Chukotski Noss in the Russian tongue. Cape Serdze Kamen will be found on the chart of Billings' Voyage. It was the point where the Chukchis successfully defended themselves against the invading Russians who sought to force them to pay tribute. Beyond it, for the Russians all was mysterious Chukchi country with an unknown coast. This cape being their *ne plus ultra* it is probable that it was more or less confounded by these illiterate and ignorant hunters with the supposed eastern Cape of Asia, otherwise the Cape of the Chukchis as used by Müller. Admit this and it is not difficult to frame an hypothesis which shall account for the confusion, without recourse to the absurd charges with which Lauridsen attempts to soil the reputation of Müller, Steller and others.

When Bering named a cape near which he met a baidar-load of Chukchi who gave him some geographical information (among other things that the coast made a turn after passing it) he called this cape with great propriety the Cape of the Chukchis, as observed by Cook (ii, p. 474) and with no reference to the legendary Cape of the Chukchis above referred to.

But when Müller and others more familiar with the records of the earlier explorers came to make maps, they naturally applied the legendary name to the cape which they supposed to be the eastern end of Asia, and beyond which the coast makes a turn to the west. Müller

believing in a great cape or peninsula on the northern coast of the Chukchi country supposed this to be the true Cape Chukotski, and to the eastern Cape of Bering he left the name of Serdze-Kamen, probably knowing little about the original Cape Serdze. And as Bering, by the ambiguity of his journal, gave color to the idea that he had rounded East Cape and pursued the north coast west of it for a few hours before turning homeward, what more natural than that those little acquainted with the region should speak of his turning back from near Serdze-Kamen? Thus Cook, following out the same idea derived from his study of the map and journal in Harris, transferred the name to a point in the latitude at which Bering turned back, on the coast which he supposed him to have surveyed. There is plenty of confusion here but no just ground for supposing malice in it.

A publication which throws much light upon Bering's voyage of 1728 was printed by Vasili Nikolaievich Bergh (or Berkh) a well known writer on geographical matters in connection with Russian history. It is in the Russian language and the title may be translated as follows:

First Sea Voyages of the Russians undertaken for the settlement of this geographical problem—Are Asia and America united?—and performed in 1727, 28 and 29, under the command of fleet captain of the first rank, Vitus Bering. To which is added a short biographical account of Captain Bering and some of his officers. St. Petersburg, Academical printing office, 1823. 8°. 3 pr. l. iv, 126 pp. 1 map. Russian text.

This book was printed, as many private books are, at the printing office of the Imperial Academy of Sciences, but was not published or printed by the Academy. The only copies I know of are those in the library of the Academy and one in the British Museum library, neither of which I have been able personally to consult. But through the kind offices of Dr. S. Hertzenstein, of the Zoological Museum of the Academy, I learn that Bergh found in the Archives of the State Admiralty Department the logbook of midshipman Peter Chaplin entitled, "Midshipman Peter Chaplin's journal of the Kamchatka expedition of 1725-1731." From this MSS and from the notes of G. F. Müller and Admiral Nagaieff, Bergh compiled his work. Chaplin's journal is not reprinted verbatim but only paraphrased by Bergh who adds his own commentary on the subject matter, and occasionally gives extracts from Chaplin whose logbook seems to have been kept in a model way.

An effort will be made to obtain a copy of the original logbook,* but for the present we are obliged to be content with what of authenticity

* Simultaneously with the proofs of this paper the work of Bergh has been communicated to me through the liberality of the University of Upsala, Sweden. The results of a critical examination of it will form the subject of a later paper as the present publication cannot be delayed.

remains to the data which have been translated or paraphrased by Bergh, Lauridsen and Olson, necessarily submitting to more or less modification in the process.

The most authentic and important document for the history of this voyage is naturally the official report handed in by Bering himself and printed in the Journal of the Military Topographical Depot of the Russian Army, volume x, pp. 67–79, St. Petersburg, 1847.

This journal is a quarto and the report is printed *verbatim et literatim* if one may judge by the archaic and mispelled words with which it is adorned. It comprises Bering's report including his instructions, a table of geographical positions, and a painfully detailed table of routes and distances by which his position in Kamchatka was computed. This report has never been translated in full and unmodified, the original is thought to have been lost. The present publication is not referred to by Lauridsen and was apparently unknown to him. I have therefore thought it worth while to prepare an English version of the report and geographical table which are incorporated in this paper.

The result shows that the previous versions of the report which have appeared were more or less mutilated or colored by the editors printing them, probably with the view of making the report of more popular interest to their readers but with injurious results to its historic value for reference.

We now come to the latest contributions to the subject. If it were not for the deficiencies in them, which seem to me serious, this paper would not have been prepared, but it seemed to be a pity that the sources of information in regard to Bering, accessible to those who do not read Russian should not be both more impartial and more accurate.

Vitus J. Bering og de Russiske opdagelsesrejser fra 1725–43. Af P. Lauridsen. Udgivet med understöttelse af den Hielmstierne-Rosencroneske stiftelse. Kjöbenhavn. Gyldendalske Boghandels forlag (F. Hegel & Sön). Fr. Bagges bogtrykkeri, 1885. Small 4°, six prel. l. 211 pp., 4 sheets of charts, one plate, one wood-cut.

This work is an attempt at a life of Bering which should combine an account of his career with a reversal of the generally received opinion in regard to his indecision of character. It embodies a general polemic against those who at different times have criticised the explorer. It contains a paraphrase of some portions of Bergh's work which had not previously been accessible in any language except the Russian, yet which would have been much more valuable in the shape of exact translation and quotation. The author labored under the disadvantages of not understanding the language in which all the original records both printed and in manuscript are written; of having little or no

familiarity with nautical surveying or cartography; and of being apparently unacquainted with the best modern charts of the region. His criticisms of others are couched in very heated and not altogether parliamentary language, and he is the victim of a narrow spirit of nationalism which is sometimes mistaken for patriotism. Nevertheless he has brought together a great deal of information: it is evident, in spite of his violent criticisms, that he has not intended to be unfair, since he puts on record in several instances evidence damaging to his own views which would not otherwise have come to light; and he has certainly exhibited Bering's valuable qualities in a manner which will do much towards rehabilitating his reputation.*

Review: Bulletin of the American Geographical Society for 1885. New York, the Society, 1885. pp. 285–298.

This review forms part of a "Reply to criticisms upon the voyage of the Vega around Asia and Europe," by Baron A. E. von Nordenskiold, translated from the Swedish by Vere A. Elfwing. It is addressed only toward certain points in Lauridsen's work, and contains valuable corrections of certain errors therein, and information in regard to the work

* I may take opportunity in this place of replying to certain criticisms of Mr. Lauridsen on the chronological chapter of my work on Alaska and its Resources published in 1870.

That chapter was and was stated in its introductory paragraph to be a compilation from the authorities on the subject. It contained no original matter except that relating to explorations subsequent to 1865.

For Bering's two voyages I consulted the report on the Russian Discoveries printed by order of the Empress and under the auspices of the Imperial Academy of Sciences at St. Petersburg, prepared by the distinguished geographer Müller, himself a member of the second expedition and personally acquainted with the actors in those scenes. No more authoritative printed document exists on the subject. The supposed errors animadverted upon by Mr. Lauridsen are either taken directly from Müller, or are inferences drawn from his report. Some of them the critic has misunderstood or misconstrued, which from the necessarily extreme condensation of my table is particularly easy. The expression of surprise that Bering passed through Bering Strait without seeing the Diomedes, was warranted by the fact that Bering nowhere mentions their name or speaks of seeing any islands in their location, nor are they on his earliest printed charts. This point, however, will be more fully dealt with later. If I were to re-write that chapter I should probably modify the criticisms of Bering's character which appear in it; but at the time it was written I was fresh from four years' exploration in the same region, and was particularly impressed with his failure to secure better results when to do so would have been so easy, as well as directly in the line of his duty.

XUM

of Strahlenberg and the other early cartographers of Eastern Siberia. It is a translation of a paper published in *Ymer* for 1885, to which for exact accuracy reference should be made.

Russian explorations, 1725–1743. Vitus Bering: the discoverer of Bering Strait. By Peter Lauridsen (etc.). Revised by the author and translated from the Danish by Julius E. Olson (etc.). Chicago, S. C. Griggs & Company, 1889. 8° xvi, 223 pp., 2 cuts, 2 folding sheets of maps.

This edition is a good deal condensed, especially in the matter of references, and does not have all the illustrations of the original. There are also a good many slips or typographical errors, which affect its value as a work of reference. Some of those important in connection with the present paper are as follows: page 31, line 4, "60° 50′ N." latitude should be "62° 50′." On the last line of the same page "longitude" should be "latitude." Page 32, after "cloudy weather" in the second line from the bottom, the whole remaining record of August 15th is omitted altogether. The sentence beginning "From noon" relates to August 16th, nautical reckoning. Page 33, line 5, "30° 19′ east" should be "30° 17′ east:" line 20 after "half west" should be inserted "south by east, by compass." Page 51, line 4 from bottom, "latitude" should be "longitude."

Review: Nation (The) New York, vol. xlix, No. 1275, p. 454. Dec. 5, 1889.

I may add that a number of references to Russian articles treating of Bering will be found in my Bibliography of charts and publications relating to Alaska and adjacent region, published by the U. S. Coast Survey in 1879.

XUM

Report of Fleet-Captain Bering on his Expedition to the Eastern Coast of Siberia.

To the most Serene Sovereign, the high and powerful, the Empress of all the Russias :

A short relation of the Siberian Expedition upon which was sent

Of your Imperial Majesty the most humble servant and fleet-captain, W. I. Bering.

On February 5 of the late year 1725 I received from her Imperial Majesty the Empress Ekaterina Alexievna, of happy and well-deserving memory, the autographic instructions of his Imperial Majesty Peter the Great, of happy and well-deserving memory, a copy of which is hereunto affixed.

Instructions.

(1.) There should be built on the Kamchatka [River], or at some other place adjacent, one or two boats with decks.

(2.) With these boats [you are directed] to sail along the coast which extends northwards and which is supposed (since no one knows the end of it) to be continuous with America.

(3.) And therefore [you are directed] to seek the point where it connects with America and to go to some settlement under European rule, or if any European vessel is seen, learn of it what the coast visited is called, which should be taken down in writing, an authentic account prepared, placed on the chart and brought back here.

The following were the instructions given me by the former General Admiral Count Apraxin, in which were written : "Artisans, laborers and whatever, in my opinion, is necessary for the expedition, are to be demanded from the chancellor's office of the government of Tobolsk and monthly reports sent to the Imperial Admiralty College."

Before receiving these instructions, January 24, a lieutenant and 26 men of my command had been ordered to service on the expedition by the Admiralty College with the necessary equipment for 25 wagons. The whole number of my command sent out amounted to 33 men who were ordered to Vologdie and from St. Petersburg to Tobolsk by a route which passed through the towns here named : through Vologdie, Totma, Upper Ustiuk,

Solwichergodsk, Kaigorodok, Solkamsk, Verkhoturia, Turinsk, Epanchin and Tiumen.

On the 16th day of March we arrived at Tobolsk and were there until the 15th day of May because of the lateness of the season interfering with travel. During the delay at Tobolsk requisitions were made for the necessary outfit for the expedition.

May 15th we left Tobolsk by water down the Irtish to Samarovska Yama, on four boats of the kind called by the Siberians "dostcheniki," on which were loaded all the outfit brought from St. Petersburg or obtained at Tobolsk; together with a chaplain, commissary, sub-officers and thirty-four soldiers.

I had previously sent a garde-marine officer, on a small boat furnished by the Tobolsk authorities in obedience to the orders of the Naval College, to the proper settlements where the preparation of freight-boats had been ordered on the Yenisei and Uskut rivers, and I ordered him to sail to Yakutsk.

From Samarovska Yama the Obi river was ascended to Surgut and to Narim, and thence the Ket river to Makovska post. From Tobolsk to Makovska as we traveled live Ostiaks who were formerly idolaters, but, since the year 1715, through the labors of the Metropolitan of Tobolsk they have been converted to the true faith. From Makovska post to Yeniseisk the route lay overland. From Yeniseisk to the Ilima-mouth we proceeded also in four boats by way of the Yenisei and Tunguska rivers. On the Tunguska there are three rapids and several shoals; rapids be it understood where across the whole width of the river large rocks stand high in the water, with a passage only in one or two places; and shoals, similarly under water and above water but composed of small stones, alternate with rapids and with places where the water in the river is shallow for the distance of one or two versts, and which are not surmounted without a great deal of labor. From Yeniseisk in pursuance of orders from Tobolsk we took thirty men, carpenters and smiths.

On the Ilima river, on account of rapids, bars and shoal water, the barges could not be taken to Ilimsk. For a certain distance only small canoes were available, for which reason the heaviest part of the outfit was reserved to be sent by sledges in winter.

Lieut. Spanberg, with a party of thirty-nine carpenters and laborers, went by land from Ilimsk by the Uskut to the river Lena, to prepare during the winter fifteen barges on which the command and its equipment should be floated down to Yakutsk.

I remained with the rest of the party near Ilimsk just below the Uskut, because at Ilimsk there are few houses and on account of the difficulties involved in a winter journey to Yakutsk, from the deficiencies of transportation, the deep snow and the severe cold, which prevented us from proceeding.

To these reasons [was added] the necessity, according to the orders from the authorities at Tobolsk, of drawing the provisions for the expedition from Irkutsk and from Ilimsk down to Yakutsk because at the latter place grain is not cultivated. During our wintering at Ilimsk I made a sledge journey to Irkutsk to advise with the local Voivod who had previously been Voivod at Yakutsk and who understood what would be needed by us in transporting our outfit from Yakutsk to Okhotsk and Kamchatka, since I did not possess any actual information in regard to that region. During the last days of winter travel I went over to the Uskut and obtained from Irkutsk twenty additional carpenters and smiths for the work of the expedition and two coopers from Ilimsk.

On the Tunguska, Ilima and Lena rivers to the Vitim live the so-called Tunguses, people who own reindeer which they use as draught animals, while those who do not own deer live near the rivers on fish and travel in canoes made of birch bark. These people are idolaters.

From Uskutsk on fifteen barges, in the spring of 1726, we descended the Lena to Yakutsk. From the river Vitim down to the Lena, on both banks live Yakuts with a smaller proportion of Tunguses. The Yakuts possess herds of cattle, plenty of horses and cows by which they subsist, and are contented with the product of their herds, depending but little on fish except where their cattle are too few. They pay an idolatrous reverence to the sun and moon as well as to birds, such as the swan, eagle and crow. They also hold in great honor their own fortunetellers, known hereabouts as *shamani*, each of whom owns small idols or figures which they call *shaitan*. By their own account these people are of Tartar origin.

On reaching Yakutsk in boats I required the aid of all the people of my command. Thirteen flat-bottomed barges which had been constructed at Uskutsk, under Lieut. Spanberg, proceeded by water on the Lena down to the Aldan to ascend that river, the Maya and the upper Yudoma. Such a cargo could hardly have been transported to that distance overland on horse-

back where but little in the way of subsistence was obtainable from land or water. The Cross of Yudoma might only be reached with great difficulty, but if successful the expense would be less than if the material had been carried on the backs of horses. I myself with a few people crossed from Yakutsk to Okhotsk with pack horses, as is the general custom. The load or pack taken is only about five puds to one horse, less than by the telega [ordinary cart], the deep mire and high mountains to be traversed not permitting more, though my supplies amounted to 1600 puds. At the post called Okhotsk is a Russian village of only ten houses, and Lieut. Chirikoff was left to winter at Yakutsk with orders to come overland to the Okhotsk post in the spring.

In the last days of December, 1726, a message asking for assistance was received from Lieut. Spanberg, who had been dispatched by the river, saying that the boats had failed to get within 450 versts of Yudoma Cross and were frozen in on the Gorbeh River, where he was transporting by sledges a cargo of outfit indispensable to our party. I sent at once, from among those who were wintering with me at the post of Okhotsk, a party with dogs and supplies and brought in the Lieutenant to the post on the first day of January, 1727, but without any of the outfit, he having left the Gorbeh river November 4th, 1726. His command had been obliged by hunger to eat the flesh of their horses and even the rawhide harness, the skin of their fur clothing and the untanned uppers of their shoes. Their cargo was all left at four different places along the route, which lay through uninhabited country. The only addition to their means which they had been able to secure, was some of our own flour, to the amount of 150 puds, which on my overland journey I had been obliged to leave near Yudoma Cross on account of the death of some of my pack-horses.

Along the rivers Aldan and Maia live Yakuts of the same stock as those of the Lena and Yudoma rivers. But near and around the post of Okhotsk wander the seaside Tunguses and some Lamuts with their herds and many reindeer, who travel about winter and summer where their deer can find pasturage; and some pedestrian Tunguses who live near the sea and rivers and are professional fishermen as among the Yakuts.

February 1, ninety men with some dogs and sledges were collected and sent under Lieut. Spanberg to bring in the outfit left behind by the Yudoma river, and by the 1st of April about half

of it had been transported safely to Okhotsk. Since more remained I sent twenty-seven men to Yudoma Cross to bring over the rest of the material on pack-horses from that place, who returned in May.

In this region in winter time from Yakutsk to Okhotsk and other distant places people always travel on foot in parties of eight or ten, hauling their own sledges after them. Those belonging to our command, when sent from Gorbeh to Okhotsk, brought down ten or fifteen puds or more, the snow being seven feet deep in places and travelers in winter being obliged to dig out a camp every evening, down to the ground to keep warm.

June 30, Lieut. Spanberg in his newly built vessel sailed across the sea to the port of Bolsheretsk with a cargo of outfit and supplies and the material for the shipbuilders and workmen of our command, sent to Kamchatka to get out the timbers for a vessel, being ordered to return again for us.

July 3d, Lieut. Chirikoff arrived from Yakutsk with 2300 puds of flour, according to my instructions.

August 21, we loaded the new vessel which had returned from the land of Kamchatka, and another old boat which had been at Bolsheretsk, with the flour, and the whole command then at Okhotsk proceeded across the sea to Bolsheretsk. The officer who had been left to guard the provisions which had not arrived from the wintering place on the Gorbeh river was directed to float them down again and take a receipt from the authorities at Yakutsk and endeavor, the following year, to deliver to the command in Kamchatka some part of the provisions, iron and tar.

It was necessary to take the supplies from the mouth of the [Bolshoia] river to the post of Bolsheretsk by water in small boats. At the post were fifteen houses inhabited by Russians. For the ascent of the shallow river small boats had been built as I desired that the outfit and the most necessary part of the provisions should be transported to the upper Kamchatka post, a distance of 120 versts by water. The transportation between Bolsheretsk and Upper and Lower Kamchatka in winter was entirely carried on by the use of the native dogs. Every evening it is necessary to dig out the camp in the snow, in order to get shelter from whirlwinds of snow which in this region are called *poorga*. If one makes camp in an open place free from snow, these snow squalls are liable to overwhelm the party and they may perish.

At Upper Kamchatka there are seventeen and at Lower Kamchatka fifty houses, at another place [Middle Kamchatka] where there is a church are fifteen houses, and in all these settlements there are not over 150 Russian subjects, who live by the collection of the *yassak* [tribute money], beside those who were brought to the country on our expedition.

In coming over to Bolsheretsk we brought 300 puds of whale blubber obtained from a whale cast up by the sea, which served us as money, together with the Circassian tobacco which is here commonly so used.

In the southern part of Kamchatka live Kuriles, in the northern part Kamchadales, whose language is peculiarly their own with but few introduced words. Of these people some are idolaters, others believe in nothing and are strangers to all honesty. The Russians who live in Kamchatka and the indigenes grow no grain and have no domestic animals except draught dogs. They dress and subsist upon what they can get, principally fish, roots and berries, in summer time wild fowl and large marine animals. At present in the wilderness of Yakutsk, the convent, which is of the same age as the Kamchatka churches, cultivates barley, hemp and turnips. Here only turnips are grown by the people of the three settlements, but they grow very large, in Russia they are smaller, here there may be four turnips to a pud. I brought with me on my journey some rye which was sowed around the establishments near us, but whether it ripened or not I did not ascertain. The frost strikes early into the ground in this region and the absence of cattle renders it difficult for the people to plow.

The natives described and from whom the yassak [tribute] is collected, belong to the Russian Empire and are all savages. They are known for their dirt and bad passions. If a woman or any animal brings forth twins then one of them is smothered, the hour it is born, and it is regarded as a great fault if one does not smother one of the two.

The Kamchadales are very superstitious. If there is any one who is very ill, even a father or mother, or near the point of death, they will carry them out into the woods and leave them without nourishment for a week together whether it be winter or summer, from which treatment many die. The dead are not covered with earth but are dragged out and left to be eaten by dogs. The house of a man who has died is abandoned. Among the Kariak people it is the custom to burn the body, although this is forbidden.

By the time of our arrival at the Lower Kamchatka post the ship-timber for our vessel was in large part prepared, and upon the 4th of April, 1728, was put upon the stocks for the vessel, which, with God's help, was finished by the 10th of July, the timber being hauled by dogs. Tar was made from the native tree which is called *Listvennik* [spruce], since the tar which we should have brought with us had not arrived.

Before this it was not known here that tar could be obtained from the native trees. So also for the sea voyage, the deficiency of spirit made from grain was supplied by a liquor distilled from herbs, and salt was made by boiling sea water. To increase our store of sea provisions, in place of cow's butter, fat was tried out from fish, in place of meat fish was salted. The vessel was provisioned with everything needful for forty men for a year. On the 14th day of July we went out of the mouth of the Kamchatka river into the sea, in obedience to the autographic orders given me by his Imperial Majesty Peter the Great, as the map constructed for that purpose will show.

August 8th, having arrived in north latitude 64° 30′, eight men rowed to us from the shore in a skin-boat, enquiring from whence we came and what was our business there. They said they were Chukchi, (whom the Russians of these parts have long known) and as we lay to they were urged to come to the vessel. They inflated some floats made of sealskin and sent one man swimming to us to talk, then the boat came up to the vessel and they told us that on the coast lived many of their nation; that the land not far from there takes a decided turn to the westward, and they also said that at no great distance from where we were, we should see an island. This proved true, but we saw nothing valuable upon it except huts. This island in honor of the day we named St. Lawrence, but we were not able to see any people upon it, though an officer was sent in a boat from the vessel on two occasions to look for inhabitants.

On the 15th of August we arrived in the latitude of 67° 18′ and I judged that we had clearly and fully carried out the instructions given by his Imperial Majesty of glorious and ever deserving memory, because the land no longer extended to the north. Neither from the Chukchi coast nor to the eastward could any extension of the land be observed. If we should continue on our course and happen to have contrary winds we could not get back to Kamchatka before the close of navigation and might be

obliged to winter in that region, not only without a harbor, but where no fuel could anywhere be obtained, where the native people do not acknowledge the authority of the Russian government, but are wholly independent and united against us in refusing to pay tribute.

From the mouth of the Kamchatka river and all the way to this place along the seacoast wind elevated mountains, resembling a wall in steepness, and from which the snow does not disappear in summer.

On the 20th of August four canoes were observed rowing toward us, containing about forty people who were Chukchi of the same sort as those whom we had met before. They brought for sale meat, fresh water, fish, fox skins, of which fifteen were of the white fox, and four walrus teeth, which my people bought of them for needles and flint-and-steels. They said that some among them had been overland with reindeer to the Kolyma river and that they never went by sea to the Kolyma; but, at a great distance, by the seashore lived some of our people, born Russians, people whom they had known for a long time, and one of them said that he had been at the Anadyr post to trade. To other questions they gave the same answers as the Chukchi previously seen.

On the 2d of September we entered the mouth of the Kamchatka river and wintered at the post of Lower Kamchatka.

On the 5th of June, 1729, having repaired the vessel which had been laid up, we went out of the mouth of the Kamchatka river and put to sea to the eastward, because the inhabitants of Kamchatka declared that on fine days land could be seen across the sea. Though none of our own people had observed it, we went out to determine the authenticity of the information. We sailed nearly 200 versts and saw not the slightest trace of land. We sailed around the south point of Kamchatka to the mouth of the Bolshoia river, making a chart of this part which had not previously been delineated. From the mouth of the Bolshoia river we sailed across the sea to the post of Okhotsk having left at Lower Kamchatka and at Bolsheretsk, out of the supplies received by us from the authorities of Yakutsk, flour, meal and dry salt meat to the amount of 800 puds.

On the 23d of July the vessel reached the mouth of the Okhotsk river, where the outfit and supplies of the expedition were turned over to the governor and I, with my command, on

hired horses, crossed over to Yudoma Cross and thence in canoes down the Aldan river, crossing over at Belskoi and below, and carrying everything on pack horses over to Yakutsk.

The whole journey occupied the time from Okhotsk, July 29th, to Yakutsk on the 29th of August. We remained in Yakutsk until September 3d, and from September 10th until October 1st traveled in two barges on the Lena when we were arrested by ice at the settlement of Peleduie. Here we were detained until the 29th of October, by the absence of snow and the presence of small ice in the Lena. When the ice solidified we proceeded to Ilimsk and from Ilimsk to Yeniseisk on the Tunguska river, stopping at Russian settlements; and from Yeniseisk to Tomsk with Russians and converted Tartars; from Tomsk to Chausk Ostrog, Russian settlements; from Chausk to Tari by the Barabinskoi steppe; from Tari to Tobolsk by the Irtish river among the Tartars; arriving at Tobolsk January 10, 1730. From Tobolsk for St. Petersburg we left on the 25th of the same month, following the same route by which we originally reached Tobolsk from the capital. We arrived in St. Petersburg March 1, 1730.

Note.—The extensive tabular itinerary covering two quarto pages, showing the details of the route traversed in going to Kamchatka, the distances and directions from point to point (except during the sea voyages), the native tribes in the region traversed, etc.—is not reproduced, as it contains no information of importance in the present connection. The other table, showing the astronomical position estimated for the more important places is herewith transcribed.

To get the approximate Greenwich longitude 67° should be added to the longitudes in the table which are reckoned from Tobolsk.

I have provided a tabular itinerary, which shows the dates of the events of the expedition, derived from Bering's Report and from other sources, which are indicated by letters. B stands for Brookes' edition of Du Halde; H for Campbell's version in Harris; M for Müller's account; and L for Lauridsen. The astronomical events are taken from Oppolzer's standard catalogue of solar and lunar eclipses.

It will be noted in the following tables there are a few discrepancies of single days compared with Lauridsen's account or other authorities. These I take to be due to the use in the ship's journal of the nautical day in which the nautical second day of the month begins on the first calendar day at noon and ends at noon on the second calendar day, so that events occurring during the first twelve hours of the nautical day would have a date one day later than the true calendar date.

Catalogue of the towns and notable Siberian places put on the chart through which the route passes, with their latitude and longitude, the latter computed from Tobolsk.

Cities and Places.	Latitude N.	Long. E. of Tobolsk.
Tobolsk	58° 05′	00° 00′
Samarofska Yama	60 17	00 30
Town of Surgut	60 51	5 18
Town of Narim	58 48	14 35
Ketskoi post	58 19	— —*
Losinoborski convent	58 17	— —*
Makoffska post	58 03	23 13
Yeniseisk	58 20	25 12
Kashim convent	58 37	32 00
House of Simakhina, Ilima river mouth	57 25	35 16
Ilimsk	56 40	36 44
Ust Kutskoi post	56 40	38 26
Kirinski post	57 50	41 01
Yakutsk	62 08	57 53
Okhotsk post	59 13	76 07
Mouth of Bolshoia river, Kamchatka	52 42	89 51
Upper Kamchatka post	54 48	— —*
Lower Kamchatka post	56 11	— —*
Mouth of Kamchatka river	56 03	96 10
Cape St. Thaddeus	62 20	111 32
West cape, Holy Cross bay	65 35	115 15
East cape, Holy Cross bay	65 28	115 37
Preobrazhenia bay	65 01	120 30
Chukotski cape, east end	64 25	122 55
St. Lawrence island	64 00	122 55
St. Diomede island	66 00	125 42
Place from which we turned back	67 18	126 07
South cape of Kamchatka	51 10	89 51

*These longitudes absent from Bering's own report are supplied by Campbell in his list, probably from the chart.

In the Table of positions the addition of 67° will reduce the longitudes to E. of Greenwich. It is probably from this table that Dr. Campbell derived his list, in Harris, which is, barring

Itinerary for Bering's First Expedition.

Dates corrected to ordinary calendar, beginning at midnight.

1725.	Authorities.	Date. Old Style.	Date. New Style.
Advance party under Chirikoff left St. Petersburg	H. L.	Jan. 24.	Feb. 4.
Bering followed	B. L. M.	Feb. 5.	Feb. 16.
Bering arrived at Tobolsk	B. H. L. M.	Mar. 16.	Mar. 27.
Bering left Tobolsk	Bering.	May 15.	May 27.
Bering arrived at Ilimsk, where they spent the winter of 1725–6	L.	Sept. 29.	Oct. 10.
Lunar eclipse obs. at Ilimsk	Chirikoff.	Oct. 10.	
1726.			
Bering arrived at Yakutsk	L.	Mid. June.	End June.
Bering left Yakutsk	L.	Aug. 16.	Aug. 27.
Bering reached Okhotsk	L.	Sept. 30.	Oct. 11.
Bering's provision train arrived at Okhotsk	L.	End Oct.	Mid. Nov.
1727.			
Spanberg reached Okhotsk (Jan. 6, L)	M. H.	Jan. 1.	Jan. 12.
Vessel *Fortuna* launched at Okhotsk	L.	June 8.	June 19.
Spanberg sailed for Bolshoia river	M. H. L.	June 30.	July 11.
Chirikoff arrived at Okhotsk	B. M. L.	July 3.	July 14.
Spanberg returned with Fortuna	L.	Aug. 11.	Aug. 22.
Bering and party sailed for Bolshoia river (Lauridsen says August 19).	B. M. H.	Aug. 21.	Sept. 1.
Bering arrived at Bolshoia river	M.	Sept. 2.	Sept. 13.
Bering arrived at Bolsheretsk	L.	Sept. 4.	Sept. 15.
1728.			
Partial eclipse of moon, visible in Kamchatka, last contact $7^h\ 41^m$ P. M.	Oppolzer.	Feb. 14.	Feb. 25.
Bering arrived at Lower Kamchatka	L.	March 11.	Mar. 22.
Vessel Gabriel put on the stocks	B. H. M.	April 4.	April 15.
The Gabriel launched (Lauridsen says she sailed to the mouth of the river July 9)	B. H. M.	June 10.	June 21.
The expedition left the river to commence explorations	B. H. L.	July 13.	July 24.
The expedition sailed northward	M.	July 14.	July 25.
Bering reached his northernmost point and started on his return	M. H. B. L.	Aug. 15.	Aug. 26.
They reached the Kamchatka river on their return	H. L.	Sept. 2.	Sept. 13.
1729.			
Total eclipse of the moon, visible in this region, beginning at $6^h\ 06^m$ A. M.	Oppolzer.	Feb. 2.	Feb. 13.
Bering sailed E. from Kamchatka river (Lauridsen says July, which is erroneous)	M. H.	June 5.	June 16.
Bering steered to the southwest	L.	June 8.	June 19.
The party arrived at Bolsheretsk		July 2.	July 13.
Bering sailed for Okhotsk	L.	July 14.	July 25.
Bering arrived at Okhotsk	M. Ber.	July 23.	Aug. 3.
Bering left Okhotsk	H.	July 29.	Aug. 9.
Total eclipse of the moon same day, but not visible in this part of Asia	Oppolzer.	July 29.	Aug. 9.
1730.			
Bering arrived at St. Petersburg	H. M. B. L.	March 1.	Mar. 12.

some additions, errors, and mistranslations, much the same. As Bering does not give any longitude for Lower Kamchatka post it is highly improbable that he observed it at that place, by means of a lunar eclipse or otherwise.

Chirikoff's observation of a lunar eclipse at Ilimsk made that point 30° 13′ east longitude from Tobolsk or, approximately, 97° 13′ east from Greenwich. His pedometric observations placed Ilimsk in 103° 44′ E. Gr. On recent charts Ilimsk is in about 104° E. Gr., so that the eclipse observation was in error about 6½ degrees. The meridian used on the voyage of 1728 was that of Lower Kamchatka, based on pedometric observations from Ilimsk computed by means of a traverse table. These, according to Chirikoff's journal, gave for the Lower Kamchatka post a meridian of 126° 01′ 49″ east from St. Petersburg or about 156° 02′ east from Greenwich, which is in error about six and a quarter degrees. Discarding the eclipse observation and using only the pedometric observations from Tobolsk to Lower Kamchatka the result for that place is 162° 33′ E. Gr., which is very near the truth. I have no doubt that this result is what was finally used in the chart (though not in the original report) and, therefore, that all the observations of Lauridsen and others in regard to the alleged eclipse in Kamchatka are based on a misunderstanding and without value.

Synopsis of the Voyage.

The dates are reduced to the Julian calendar from the nautical account. The longitude is stated in degrees east from Greenwich.

June 10/21, 1728. The vessel, which was named the *Gabriel*, was launched at the Lower Kamchatka fort and loaded with a year's supply of provisions for forty men (B. C. H. M.). She resembled the packet boats used in the Baltic.

Notes.—This vessel was constructed of the Kamchatkan spruce, a species according to Kittlitz closely resembling *Abies canadensis* of America. There is also a smaller species, *A. mertensiana*, and by distillation of these two trees the deficiency in their supply of tar or pitch was made up. The rigging, sail-cloth, oakum and anchors had been transferred with great labor from Tobolsk. The planking and timbers were doubtless fastened with trenails and not with spikes, so the amount of iron used was much smaller than it would be in most modern vessels. The provisioning of the expedition is the subject of a fanciful paragraph garbled from Bering's original report, which

has been quoted by every one of the historians of the voyage from D'Anville to Lauridsen. I transcribe it from Brooke's translation of 1736, pp. 437-8.

"The provisions consisted of Carrots for want of Corn (=grain or wheat), the fat of Fish uncured served instead of Butter and salt fish supplied the place of all other meats."

Campbell in Harris' Voyages, p. 1020, still further enlarges this statement and Lauridsen puts it

"Fish oil was his butter and dried fish his beef and pork. Salt he was obliged to get from the sea," and "he distilled spirits from 'sweet straw.'"

This gives a totally false idea of the supplies provided for the expedition. Bering received from Yakutsk over forty-two tons of flour, and large numbers, fifty at a time, of the small Siberian cattle were driven on the hoof to Okhotsk where their flesh was partly dried and partly salted. On his return he delivered surplus supplies to the proper officers in Kamchatka and at Okhotsk ever 30,000 lbs. of meal, flour and salt meat. There were at that time no carrots to be had in Kamchatka as Bering himself testifies. Salted salmon then as now, formed a staple article of diet in Kamchatka and was without doubt included in his stores. The delicate fat obtained by boiling the bellies of the salmon, is annually prepared in Kamchatka and is regarded to this day as a great delicacy (cf. Voyage of the *Marchesa*, 2d edition, p. 135.) A store of it might without any hardship be furnished to the commander for use as butter. Salt he obtained as it is usually obtained by evaporating sea-water, and the absence of strong drink of European origin was supplied by a distillation of the stalks of the bear's foot or "sweet herb" of the Cossacks (*Heracleum dulce* Kittlitz), long used for that purpose by the Russians in Siberia and from which, even in modern times, according to Seemann, the Kamchadales secured additions to their scanty supply of syrup or sugar.

The supplies then of the expedition, were not inferior to those in common use at sea at that period, and as far as health is concerned were certainly less likely to result in an invasion of scurvy than the use of salt beef and pork alone would have been.

It must be remembered that the fare on naval vessels all over the world in those days, was rude and coarse to a degree now long unknown and that it was not until the voyages of Cook, nearly half a century later, that the antiscorbutic and varied regimen, now usually enforced by law in maritime nations, was even thought of.

The force crowded together on the little *Gabriel* is enumerated by Lauridsen presumably from the account of Bergh.

It consisted beside the commander, of Lieutenants Martin Spanberg and Alexie Chirikoff; Second Lieutenant Peter Chaplin, Doctor Nieman, a quartermaster, eight sailors, a worker in leather, a rope maker, five carpenters, a boatswain, two cossacks with a drummer and nine marines, six servants, stewards, etc., and two Kariak interpreters, a cabin boy and a pilot, in all forty-four persons.

It is not clear from Lauridsen's account whether in the above list are or are not included the two mates, Richard Engel and George Morison, or the cartographer Potiloff, who started with Bering from St. Petersburg. Luzhin was left behind, being ill.

July 13 24. The variation of the compass was determined to be 13° 10′ easterly (L.). In the afternoon (being the 14th nautical reckoning) the vessel left the Kamchatka river. (B. C. H.) They steered to the northeast along the coast, which was kept in sight to the north and west, in from nine to twelve fathoms water. As the point of departure Cape Kamchatka was determined to be in north latitude 56° 3′ (M. L.)

Notes.—The variation of the compass in 1885 was 2° 30′ easterly (Schott). As will be seen by the Table of Positions, the latitude above given for the cape is not the same as that adopted by Bering on his chart. The depth mentioned shows that the Gabriel must have kept within a few miles, probably not exceeding ten, from the shore and the very slow progress made, as indicated by the log, not much exceeding two miles an hour gives rise to the suspicion that, in the early part of the voyage, in order to keep their survey continuous, they probably lay to during the hours of darkness. Off Karaginski Island the variation of the compass was determined to be the same as at the mouth of the Kamchatka river.

From this date to the 27th, the accessible authorities give no data, and the expedition probably pursued its way uneventfully.

$\frac{\text{July } 27}{\text{Aug. } 7}$. This day a prominent Cape was passed at a distance of some three miles. [It was named St. Thaddeus, after the saint on whose holy day it was again seen on the return voyage.] Many grampus, porpoises, seals and sealions were seen (L.).

Notes.—This Cape St. Thaddeus is not the cape of the same name on modern charts, but the cape now known as Cape Navarin. This is evident from Bering's chart. Bering's position for the cape is in error about fifteen miles in latitude and three degrees in longitude on his chart, while in the list of positions, the error is only about five miles of latitude and half a degree in longitude.

From near Cape Thaddeus Bering stood across Anadyr Gulf, out of sight of the low land, missing Anadyr Bay, and thereby falling into the error of placing on his chart the mouth of the Anadyr River south of the cape. The error was subsequently corrected by G. F. Müller.

Lauridsen observes (American edition, p. 30), that "having sailed past the Anadyr River without quite being able to find their bearings, in regions of which they had not a single astronomical determination,"

etc. This is absurd. They had a compass and there is no reason why they should not find their bearings, and it is certain they were there to make observations and not to verify those already made. No apology is needed for Bering's determination to press more rapidly northward. It was in accordance with common sense, considering the lateness of the season and the uncertainty of what they had to accomplish before the season closed.

Aug. 1/12. Festival of the Holy Cross. The expedition saw land to the northward and soon after entered a great bay which they named Holy Cross Bay. This they explored to the river at its head which they named Bolshoia (Great) River, and on the western point of entrance the latitude was, Aug. 2/13, observed to be 65° 35′ north, while the longitude by dead reckoning was estimated at 182° 15′ east of Greenwich, and the magnetic variation ¾ of a point easterly.

Notes.—Lauridsen says (p. 31, American edition) that in Holy Cross Bay the Gabriel spent two days under sail in search of fresh water and a place to anchor." This is extremely singular, as there is an anchorage immediately at the entrance to the bay, on the starboard hand, and runs of fresh water are abundant. The application of an obvious correction* to the list of positions given by Campbell makes the position at the western elbow or spit, at the mouth of Holy Cross Bay, that which is given above. This position is over a degree too far west and over six miles too far south. But Lauridsen (quoting Campbell without observing the blunder?) not stating the source of his information, gives a position (N. Lat. 62° 50′) which is two hundred and twelve miles too far south and the English translation improves upon this by making it 60° 50′, or three hundred and thirty two miles south

* In Harris' Voy., 2d ed., ii, p. 1021, Bering's table of positions is printed:

Nischuvi Kamschatska Oostrog, (N. Lat.) 56° 11′ (Lon. E. Tobolsk), 98° 30′
The Mouth of the river of the Apostle *Thadeus* and the Cape ..... 56° 03′, 96° 10′
The Elbow of the river *Swetoi Krest* ..... 62° 20′, 111° 32′
Eastern Point ..... 65° 35′, 115° 15′

This should read, errors and misplacements corrected:

	Lat.	Long.
Nizhni Kamschatsk Ostrog	56° 11′,	95° 30′
The mouth of the River (Kamchatka)	56° 03,′	96° 10′
The Cape of the Apostle *Thaddeus*	62° 20′,	111° 32′
The western cape (or spit) of Svietoi Krest Bay	65° 35′,	115° 15′

The words in parentheses are added by the writer for clearness. It is somewhat surprising that in using this table nobody seems to have recognized these errors.

of the truth, or two hundred and sixty-five miles south of the entrance to the bay as platted on Bering's own chart.

Bering's table in his report and Bering's chart as printed by D'Anville differ from each other fifteen miles in latitude and two degrees and twenty-five minutes or nearly seventy-five miles in longitude. The chart is the more correct, but it differs more than thirty miles in latitude and nearly a degree in longitude from the modern observations of Lütké and Rodgers for the same locality. After leaving Holy Cross Bay, the voyage was continued to the southeast along the "high and rocky coast" of which Lauridsen (probably paraphrasing Bergh) says that "every indentation was very carefully explored." This is obviously a flight of fancy, since a good part of this coast is low and sandy, while there is no indication of two excellent harbors which it affords, on any of the charts of Bering or his successors in that century.

Aug. 6 17, 1728. This day, the festival of the Transfiguration, found the Gabriel entering a small bay, which on that account was named Transfiguration (Preobrazhenia) Bay. Here they anchored (L.). Lieutenant Chaplin was sent ashore for water and found native huts but no people.

Notes.—This bay has never been surveyed, and on the best modern charts is merely indicated, while on many others it is omitted altogether or the name transferred to the anchorage north of Cape Bering or to Plover Bay. Bering's position for the spit at the entrance of Transfiguration Bay is two degrees and a quarter too far east and sixteen miles too far north by the table, but his chart gives the position much more closely, with a difference from Rodgers' chart of not exceeding five miles.

Aug. 7 18. They proceeded along the coast in a south-south-easterly direction.

Note.—The total eclipse of the moon of this date could hardly have been observed by Bering, since the moon must have been close to the horizon and first contact of the shadow occurred only about five minutes before the moon set. As Bering does not mention it, it is not likely that he noted the eclipse.

Aug. 8 19. At seven in the morning a skin-boat (umiak or bidarrá) was observed to be launched from the shore, eight men getting into it and rowing toward the vessel (B.). They approached within hail, and were understood, through the aid of the Kariak interpreters on board the Gabriel, to enquire whence the vessel came and what was the object of the expedition in entering these waters. After much persuasion one of the natives left the skin-boat and swam, sustaining himself on two inflated

seal-skins tied by a pole, to the Gabriel and came on board and the others, seeing that no harm befel him, came nearer the vessel shortly afterward (M. B. C.). The interpreters had some difficulty in understanding all the natives said, but it was gathered from their conversation that these people called themselves Chukchi (or by an analogous name) ; that they were acquainted with the Russians, by report or otherwise, that there were numerous settlements of their people along this shore ; that the Anadyr River lay far to the west (L.) ; that to the south and east lay an island which would soon be visible to the people on the Gabriel if they continued on the course they were then steering ; that in the vicinity of this island the shore of the mainland changes its direction and extends beyond to the north and then to the westward (B. M. C. H.). The man who had boarded the vessel was given some presents and sent back to the native boat, in the hope that he would persuade his comrades to come on board the Gabriel, but, suspecting some evil design, the natives pulled away toward the shore and disappeared. According to Bergh, Chaplin's journal expresses regret that more important information could not be obtained owing to the difficulty in interpreting what was said by the Chukchi. At noon the latitude was estimated to be 64° 30′. In the afternoon the cape mentioned by the Chukchis was seen.

Notes.—The account given in Bering's report, and variously rendered by Müller, Brooks, D'Anville and Campbell, differs in several details from that given in Chaplin's journal and described by Bergh and Lauridsen. The various English versions of both fail in clearly rendering the important point gained by this interview with the natives, which was, that, at a short distance, the main coast changes its direction and turns to the north and west. These Chukchis pointed the way to the strait for the party on the *Gabriel*, and their account proved to be accurate in every particular.

The people of this part of the coast call themselves *Tsau-chú*, which is their tribal name. The similar name of another branch living near the Anadyr River has been corrupted into the word Chuk-chi, by the Russians, from which we derive our general name for these people. Lauridsen says "Breden var 64° 41′" which in the American edition stands, "the longitude (sic) was 64° 41′." But the original and all the variants of Bering's own report make the latitude 64° 30′ which is correct. If it had been 64° 41′ they would have been north of their own position for Transfiguration Bay, from which their course had been S.S.E., therefore the 41′ is certainly erroneous.

On Bering's chart he refers to the point of the coast where the shore changes its direction under the name *Chukotskago Noss*, which means the promontory of the Chukchi, though this is not the same as the

Chukchi Cape of the Anadyr Cossacks, who so denominated the eastern extreme of Asia, which they knew from report and by the voyage of Deshneff. There can be no reasonable doubt that Bering named his cape after the people who had described it to him, although the imperfections of the record leave this to be inferred. Bering's map gives the latitude of the south extreme of the cape as about 64° 02′, and it is erroneously represented as extending south of the latitude of the northwest end of St. Lawrence Island. Its real latitude is about fifteen miles further north. Cook made it 64° 13′. Chaplin's journal (according to Lauridsen) makes it 64° 18′, which would agree with the latest surveys very nearly, though the coincidence must be regarded as a happy accident in view of their imperfect tables, instruments and methods. Bering's report places its eastern extreme in 64° 25′ and (wrongly) in the same longitude as the west end of St. Lawrence Island.

Aug. 10 21. St. Lawrence's day. The island referred to by the Chukchi was seen and the vessel stood toward it, about two o'clock in the afternoon. Twice, an officer with a four-oared boat was sent to reconnoiter the coast more closely, but he saw only what appeared to be huts without inhabitants (C.). The island (of which only the northwest hilly portion was seen, owing to the hazy weather) was named after the patron saint of the day and the course of the vessel was changed to the northward.

Aug. 11 22. At noon the latitude was estimated at 64° 20′, and at sunset an attempt was made by the determination of the magnetic variation to get the longitude (L.).

Notes.—An illustration of the want of care with which Lauridsen has weighed his comments, it may be pointed out that he claims (p. 32, Am. Ed.) that on reaching latitude 64° 20′ the *Gabriel* was in Bering Strait, while two pages later, on her return southward, he declares her to have got out of the strait on reaching latitude 64° 27′! As a matter of fact, at the present day, the whalers and traders of this region consider that Cape Chaplin (more commonly known as Indian Point) forms the southwest point of entrance to the strait; and this point is situated in latitude 64° 25′ and E. longitude 187° 40′, as determined by the writer in 1880. This is perhaps the point referred to by Bering as the eastern point of his Chukotskoi Cape.

The magnetic method of determining the longitude would give correct results only accidentally, as previously explained. The result announced by Lauridsen for the present occasion is 25° 31′ east from Lower Kamchatka Ostrog or 187° 51′ east from Greenwich, which would be within a few miles of the latest determinations. But it is obvious from Bering's map that he could not have made his position less than 28° 45′ east from Lower Kamchatka, and the position above given is perhaps an interpolation from modern sources, which has been misunderstood or mistranslated. As Lauridsen has paraphrased, not quoted,

it is impossible in the absence of Bergh's original to determine who is responsible for the incongruity. An interpolation seems the more likely since Bering himself gives the longitude as 189° 55′ E. Gr.*

Aug. 12/23. From noon of the 11th to noon of this day, the Gabriel sailed sixty-nine miles, but the difference of latitude was only 21 miles. The wind was light to fresh and the weather overcast (L.).

Notes.—If the above statement be taken literally with the assumption that they were at noon of the 11th in latitude 64° 20′ and E. longitude 188° from Greenwich, it would give their position for noon of the 12th as 64° 49′ and longitude 190° 45′ E. Gr., which does not at all accord with the subsequently narrated course, etc. If we proceed on the hypothesis that it means that the log recorded 69 miles and that only 29 miles were made good (which might easily happen if the polar current were running strong on the west side of the strait) and that their course was parallel with the Siberian shore in a general way they would have been, at noon of August 12th, in latitude 64° 49′ and longitude 188° E. Gr. or thereabouts, which agrees very fairly with the known circumstances.

Aug. 13/24. A fresh breeze and cloudy weather. The *Gabriel* sailed the whole day with no land in sight and the difference in latitude was only 78 miles at noon, reckoned from noon of the 12th. The wind diminished toward night.

Notes.—On the same hypothesis as to the meaning of "difference in latitude" as the words are used by Lauridsen, the *Gabriel* at noon of the 13th would have been ten or twelve miles south from East Cape and in about latitude 65° 55′. If the words are to be taken literally, as a navigator would use them, the Gabriel would have been about fifteen miles to the northward and eastward of East Cape, which agrees much less with the subsequently detailed circumstances. With the nautical day beginning at noon on the 13th according to Lauridsen the weather began to be calm and cloudy which would check their progress.

Aug. 14/25. This is the festival of Saint Demetrius of Africa. A current was experienced during this day which was estimated to have helped the vessel northward eight miles and three quarters. This current ran from south-southeast to north-northwest. From noon of the 13th to noon of this day the vessel sailed 29 miles in addition to the current drift. At noon the latitude was estimated

* A glance at Bergh shows that this statement of Lauridsen is simply a blunder. Bergh only says they obtained the magnetic variation (25° 31′ easterly) by an *amplitude* observation! Longitude is not mentioned, nor Kamchatka.

to be 66° 41′ and high land was visible astern. At three o'clock in the afternoon high mountains were observed to the southward. which, says Chaplin, "were probably on the continent."

Notes.—Under any hypothesis either the run of the vessel was underestimated or the latitude was overestimated. Adding the estimated run to the position attained under our hypothesis for the 12th and 13th it will put the *Gabriel* at noon, August 14th, in about north latitude 66° 24′ and longitude E. Gr. 191° 30′. Chaplin's reckoning as given by Lauridsen would have put the *Gabriel* more than fifty miles off shore when the land spoken of would have been out of sight. Our hypothesis puts her about twenty-eight miles N.E. true from East Cape when the high land of either shore, under favorable circumstances, might have been seen even if the sky were overcast. Clouds do not interfere with seeing, unless attended by fog or haze. During this day the *Gabriel* had sailed between East Cape and the islands now known as the Diomedes; the shore being near by. Why then should it be noted in the log that "high land was seen astern" at noon? The high land of Siberia they had seen and sailed along for days in full sight of it. It seems to us that this excludes the idea that the log refers to the Siberian highland and that what was seen was the loom of land not before seen, as of the Diomedes or even of America. It may not have been clear to the commander and yet have been marked enough for the subordinate officer to have put it in his log, with the dead reckoning and daily notes.* On several old charts mention is made of land seen by Spanberg which is supposed to have been America, after Gwosdeff had confirmed the existence of the American mainland in that direction and Synd had landed upon it. This suggestion is not unimportant in connection with the subsequent conduct of Bering and will be referred to again in its proper connection. The further fact that all early printed versions of Bering's list of positions, refer to the modern Diomedes only as the island of *St. Demetrius* and that this day was the festival of that obscure saint, lends further confirmation to the above suggestions.

Aug. 15 26. The *Gabriel* appears to have continued to sail in a northeasterly direction until three o'clock in the afternoon, having been aided by the current to the extent of $8\frac{3}{4}$ miles and sailed 65 miles; many whales were seen and the depth averaged between 23 and 36 fathoms. Since the 13th the water had appeared whitish or discolored. The wind was moderate and the weather cloudy. Between noon and three o'clock the vessel made seven miles against a head wind. The position of the *Gabriel* at that time was estimated to be in north latitude 67° 18′ and 30° 17′ east longitude from the town of Lower Kamchatka (C. corrected).

* Lauridsen gets over the discrepancy by putting the word "still" before "seen" (Am. Ed., p. 41), but there is nothing in the original sources to confirm this view of the matter.

Note.—The nautical day Aug. 15 extending from noon of the 14th to noon of the 15th is altogether omitted from the American translation of Lauridsen's book. The position for the turning point estimated by Chaplin is manifestly by dead reckoning, as the sky was cloudy. It was not adopted in the list of positions published by Campbell in Harris' Voyages nor on Bering's map. In the former the longitude he adopts is 27° 37′ east of Lower Kamchatka fort, and this agrees exactly with the point on the coast in Du Halde's engraving of Bering's map where the mountains cease to be put down near the shore, the point on the north coast of Siberia where Lauridsen, and Chaplin as quoted by him, say Bering did not go, and the point which has been generally regarded as Bering's farthest!

If we apply the distance and direction from Chaplin's journal to the course of the *Gabriel* platted from his preceding data, literally, it will put the turning point of the voyage in N. latitude 67° 32′ and E. longitude 193° 37′ or thereabouts, which is about thirty-five miles off the American coast southwest from Cape Seppings. But if we do this the position is far from agreeing with Chaplin's. By applying the hypothetical correction which we have heretofore used, the position would be in latitude 67° 24′ and E. longitude 193° 15′ from Greenwich or 31° east from Lower Kamchatka fort, agreeing more nearly with Chaplin. On the other hand the position off Cape Seppings agrees better with Chaplin's figures for the remainder of the day.

At this point the commander of the expedition determined to turn homeward. The *Gabriel* was put on a course S. by E. by compass (S. by W. ½ W. true, the variation allowed being 2½ points easterly) before a brisk seven knot breeze, making better time than is recorded for any part of her outward voyage.

Notes.—Lauridsen says* that, in terminating the outward voyage, Bering "announced that as he had now accomplished his task it was his duty, according to his orders, to return." Müller and other authori-

* Bergh (p. 54) quotes Chaplin's journal, which says: "At three o'clock Captain Bering announced: *that it was necessary for him, in spite of his instructions, to turn back*, and put the vessel about with orders to steer S. by E. by compass." The italics are Bergh's, who adds that, in the journal of Lieut. Chirikoff, the same statement is made in the same words. I transliterate the italicized phrases according to the schedule for Russian letters published in *Nature*, Feb. 27, 1890. "Chto nadlezhit emu protiv ukazu vo ispolnenie vozvratit'sya." This plain statement, which proves that (at the moment) Bering recognized that he was not fulfilling his orders, is suppressed by Lauridsen and of course by Bering himself when he came to prepare his official report. Lauridsen however is not satisfied with suppressing the truth, which would have weighed so heavily against his hero and his argument, but, with the truth in his possession, he has inserted in his book a statement which is diametrically opposed to it as above cited.

ties quote, more or less modified in the translation, the reasons given in Bering's report. But, as there is no reason to suppose these were uttered to the ship's company officially at the time, a consideration of them may be deferred until the total results of the voyage are discussed. The course set, according to Chaplin's journal, would, if made good, have carried the *Gabriel* east of the Diomedes and close to Cape Prince of Wales. The northwesterly current referred to by Chaplin and recognized by most navigators who have since visited those seas, would have carried the vessel more to the westward, as was actually the result, and it was probably allowed for.

August 16 27. Saint Diomede's day. The *Gabriel* had kept on her course with a free wind making more than seven knots (miles) an hour. At nine in the morning they found themselves off a high promontory on the west, where there were Chukchi habitations. On the east and seaward they saw an island, which it was proposed to call after the saint of the day. At noon the vessel had made since the previous noon 115 miles and had reached latitude 66° 02′. Continuing on their way, with a fresh breeze and cloudy weather, they sailed along the Asiatic coast near enough to observe many natives and at two places they saw dwellings. At three P. M. very high land and mountains were passed (probably the highlands near St. Lawrence Bay).

Notes.—From 3 P. M. Aug. 15th to 9 A. M. Aug. 16th is 18 hours, which at seven knots an hour (allowing the alleged excess to be the equivalent of the drift caused by the current) would amount to 126 miles. Deduct from this the seven miles sailed between noon and 3 P. M. Aug. 15th in the opposite direction and we have remaining 119 miles made on the homeward voyage at a time when the *Gabriel* was between the Diomedes and East Cape, or at least in plain sight of both. But three hours later, at noon, according to Lauridsen, they had made only 115 miles in all, although the breeze was fresh and fair. From Chaplin's position for the turning point to latitude 66° 02′ off East Cape is 96 miles. From our hypothetically corrected position for the turning point, off Cape Seppings, the distance would be to the same place 126 miles, or thereabouts. It is evident that there is a miscalculation, or an error in the record here, which, without further data, it is not possible to correct.

It is certain that Bering with whom the right of naming any new island would have rested, did not then name the island above mentioned after St Diomede. On all copies of the earlier version of his chart it appears if at all under the name of the Island of St. Demetrius. From this we may suspect that he identified it with the high land seen Aug. 14th, St. Demetrius' day, while others on board, suspecting they were not the same proposed the name of Diomede for the present

island; regarding the high land as something distinct. If the hardy and self-willed Spanberg was the one who reported the land Aug. 14th, and if he saw the high land about Cape Prince of Wales, as several old charts allege, he would have been the last to admit that the relatively small and adjacent island now seen, should be identified with his discovery.

Aug. 17 28. The breeze having been strong and fair an observation at noon indicated that the latitude was 64° 27′ and that the *Gabriel* had sailed 164 miles since noon of the 16th. In the afternoon the weather was clear and the wind became light. (The *Gabriel* must have come out of the strait this afternoon).

Notes.—A distance of 164 miles from the position of the previous noon would have put the *Gabriel* in latitude 63° 38′. The distance on the general course sailed by the *Gabriel* from 66° 02′ to 64° 27′ is about 107 miles. It is possible that in copying or printing 104 miles has become transmuted to 164 miles. There is an obvious error here of some kind.

Aug. 18/29. (Lauridsen does not refer to any record for this day, but it is probable that the wind continued light and the weather fair and that the *Gabriel* was slowly working her way westward and southward in the vicinity of Cape Chukotski.)

Aug. 19 30. In the afternoon being in the vicinity of the place where they had met the Chukchi boat on the outward voyage, four baidars were seen with their crews pulling for the vessel, which accordingly lay by for them to come up with her. There were ten natives to each baidar, or forty in all. They brought reindeer meat, fish, and fresh water in large bladders for sale for which they were suitably rewarded, while the crew of the *Gabriel* obtained from them skins of the red and the polar foxes and four walrus teeth, which the natives bartered for needles, flint-and-steel for striking fire, and iron. These Chukchi told them that they went over land to trade at the Kolyma River, carrying their goods with reindeer, and that they never went by sea. They had long known the Russians and one of them had even been to the Anadyrsk fort to trade. From this man they had hopes of gaining valuable information but he could tell them nothing more than they had learned from the first Chukchis who had been questioned.

Aug. 20 31 to $\frac{\text{Aug. 29}}{\text{Sept. 9}}$ (For this period the documents accessible to me give no information, but the *Gabriel* was doubtless

pursuing her homeward way uneventfully along the coast of Kamchatka.)

Aug. 30 / Sept. 10. A heavy storm arose with fog and the *Gabriel* finding herself dangerously close to the shore anchored near the land to ride it out. A note in Harris indicates that they may have been near Karaginski Island.

Aug. 31 / Sept. 11. At one P. M. the storm had abated, but in weighing anchor the cable had been so chafed by the rocky bottom that it parted and they lost the anchor, and were obliged to put to sea without recovering it.

Sept. 1 12, 1728. At five o'clock in the afternoon they approached and at seven the next morning entered the mouth of the Kamchatka river, thus ending the voyage.

Note.—The *Gabriel* was secured in a slough of the river and the party went up the river to the fort of Lower Kamchatka where Bering passed the winter.

It is certain that the residents of Kamchatka and others more or less familiar with the reports of Cossack explorations in Chukchi-land were not altogether satisfied with the summary manner in which exploration had been given up by Bering, and his apparent assumption that there was no adjacent land to the eastward except small islands. More or less such discussion and criticism could hardly have failed to reach his ears, and his reflections may have led him to think that, after all, he had been too hasty. Trees not indigenous to Kamchatka had been seen floating near the shores, no heavy breakers ever proceeded from the eastward and it was even alleged that land or the loom of land might be seen to the east from the coast mountains in very clear weather. On account of these and other reasons* which were urged by residents of the country, Bering determined to make a new trial. Instead of proceeding directly to Okhotsk across Kamchatka he fitted out the Gabriel for another voyage. Beside the fact that Luzhin, one of his cartographers, had explored the Kurile Islands lying next to Kamchatka, the vessel *Fortuna* during Bering's absence had doubled Cape Lopatka and was anchored in the Kamchatka River when Bering entered it on his return. It was therefore evident that the straits were navigable and the return voyage might be made that way. Spanberg was ordered to Bolsheretsk "on account of illness" (L.), and it is possible he took the *Fortuna* back there since she had already returned to Bolsheretsk when Bering reached that port, on his way to Okhotsk.

*The natives even claimed that a man had been stranded on the coast of Kamchatka in 1715, who stated that his own country lay to the eastward and contained forests with high trees and large rivers. (Lauridsen, op. cit. Am. ed. p. 51). Bering himself states that he made the search of 1729 at the instance of the Kamchatkan residents.

Lauridsen has ascribed to Bering's own initiative the willingness to make another search for land as if these ideas were original with him. It is evident that this is unjustified and fanciful. Müller's account shows that the incitement to a second attempt proceeded from the residents of the country and that Bering complied with their suggestions; and Bering says so himself in his report.

On June* 5/16, 1729, the *Gabriel* left the mouth of the Kamchatka River and stood to the eastward, directly off shore. She continued on this course about forty-eight hours, sailing a distance variously estimated at from ninety to one hundred and thirty miles. The weather was foggy, no land was seen, the wind shifted to dead ahead at east northeast, and on the third day Bering gave up the search and steered for the southern coast of Kamchatka, the extreme of which is marked by the point known as Narrow (Ooskoi) Cape, or more generally as Shovel (Lopatka) Cape, from its low square termination. He determined the latitude of this cape, and passing through the strait south of it reached Bolcheretsk on the west coast of the peninsula on the second of July. Most of this time was probably spent in tracing the form of the southern part of Kamchatka. Half way between the Kamchatka River and the coast the variation was observed to be one point easterly, and off Avatcha Bay three-quarters of a point easterly.

In the American translation of Lauridsen it is said (p. 51) that Bering fixed the difference of latitude (for which one should read longitude) between Bolcheretsk and Lower Kamchatka Ostrog at 6° 29′. But on Bering's maps the difference is only 3° 50′, while in his list of positions no longitude is assigned to Lower Kamchatka post. In Campbell's list it stands at 8° 39′, which the correction of an evident error of 98° for 95° reduces to 5° 39′. The true difference of longitude according to the latest charts is about 5° 25′. Where Lauridsen got his figures he does not state. Campbell, in Harris, states that Bering was the first navigator to double Cape Lopatka, but the *Fortuna* had made this voyage in 1728, though her commander is not known.

At Bolsheretsk Bering left a crew for the *Fortuna* which had returned thither; turned over some of his surplus stores to the local authorities and on the 14/25 July sailed from the Bolshoia River for Okhotsk. Here he arrived $\frac{\text{July } 23}{\text{Aug. } 3}$ and after some days spent in turning over government property to the local officials and procuring his horses and outfit, he left Okhotsk $\frac{\text{July } 29}{\text{Aug. } 9}$ on the overland journey to St. Petersburg. The second eclipse of the moon for the year occurred on this day, but during hours of daylight, and hence was invisible in this part of Asia.

After an uneventful but successful journey Bering arrived in St. Petersburg Mar. 1/12, 1730, bringing with him, according to Du Halde, the map and report he had prepared upon his explorations.

* Lauridsen says July, which is erroneous.

TABLE OF GEOGRAPHICAL POSITIONS DERIVED FROM BERING'S FIRST VOYAGE, REDUCED TO GREENWICH, E. LONGITUDE.

Meridian used in the original,	Tobolsk.	Tobolsk.	Tobolsk.	Ferro.	Ferro.	Greenwich.
Amount used for reduction,	+67°.	+67°.	+67°.	−18°.	−18°.	
Source of the data.	Bering* MS.	Campbell.[1]	Du Halde.	D'Anville.	Müller.	Modern charts.
Date,	1730?	1730?	1736.	1753.	1758.	1852–88.
	° ′	° ′	° ′	° ′	° ′	° ′
Okhotsk	58 54	59 13	58 54	-- --	59 20	59 20[19]
	141 30	143 07	141 20	-- --	141 15	142 40
Bolsheretsk, Kamchatka	52 35	52 42	52 40	52 40	52 54[13]	52 51
	155 28	156 51	155 25	155 30	156 30[14]	156 50
Upper Kamchatka settlement	54 10	54 48	54 10	53 40	54 28	-- --
	157 10	158 00	157 15	156 30	156 55	-- --
Lower Kamchatka settlement	55 46	56 11	55 50	56 05	56 20	56 15
	159 28	162 30[2]	159 15	159 00	159 30	162 15
Cape, at Kamchatka river-mouth	55 52	56 03	55 40	56 00	56 10	56 00
	162 05	163 10[3]	162 10	159 20	160 20	163 05
Cape Thaddeus (Navarin)	61 50	62 20	62 00	62 05	62 25	62 15
	176 05	178 32[4]	176 00	171 14	175 20	179 02
West point, entrance Holy Cross Bay	65 16	65 35	65 15	65 15	65 30	65 28
	179 40	182 15[5]	180 00[11]	175 10	178 45	181 12
Mouth of river, Holy Cross Bay	66 00	-- --	65 50	65 45	66 15	66 22
	179 40	-- --	179 50	175 00	178 15	180 45
Transfiguration Bay (east entrance)	64 45	65 01	64 40	64 25	-- --	64 45
	185 15	187 30	185 10	180 00	-- --	185 15
Cape Chukotski, of Bering	63 55	64 25	64 02	64 10	64 35	64 14
	186 55	189 55[6]	186 10	181 10	185 10	186 50

N. W. point St. Lawrence Id.	63 50	64 00	64 02	64 00	64 15	63 52
	187 00	189 55	187 20	181 20	186 05	188 27
St. Demetrius Id. (Big Diomede)	65 42	66 00	-- --	66 00	-- --[15]	65 50
	189 05[12]	192 42[7]	-- --	183 20[12]	-- --	190 25
East Cape of Asia	66 40	67 18	66 45	66 30	66 45	66 05
	189 40	193 07[8]	189 45	184 00	187 25	190 30
Bering's farthest	not	67 18	-- --	-- --	66 45[16]	-- --
	indicated.	193 07[9]	-- --	-- --	187 25	-- --
Petropavlovsk, Avacha Bay	53 10	53 12	53 15	52 50	52 55[17]	53 02
	160 02	159 50	157 00	158 55	158 13	158 39[21]
Cape Uskoi, or Lopatka[19]	50 50	51 10	51 10	51 20	51 20[18]	50 52
	155 05	156 51	155 10	156 00	157 00	156 47

[1] Date of Campbell's Harris' Voy., 1748; date of table of positions, 1728; fide Campbell, 1021, col. 2.
[2] Campbell has 98° 30′ E. of Tobolsk, an error (?), for 95° 30′ (=162° 30′ E. Gr.) Bering omits this position.
[3] Campbell's confusion of two entries is here corrected from Bering's Report.
[4] Confused with preceding entry by Campbell. [5] Campbell's confusion here corrected.
[6] The southern end of the cape is assumed to be meant.
[7] The island is omitted by Du Halde and Müller, but appears on Campbell's version of Bering's chart.
[8] Campbell, p. 1024; omitted by Bering from his report. [9] Campbell, p. 1022; also Bering's Report.
[10] Oskoi (error for Ooskoi), on most early charts; sometimes Osnoi (error for Uzhnoi = southern).
[11] Bering gives both east and west points of entrance in his table.
[12] St. Diomide on the chart. [13] Determined in 1741 by Krassilnikoff to be 52° 55′ and 156° 24′ E. Gr.
[14] From the chart; on p. 114 Müller has 156° 10′. [15] Name St. Deomed on chart, but no island represented.
[16] From Jeffrey's copy of the chart; on p. 47 of text N. Lat. 67° 18′ appears but no longitude is given.
[17] From the chart; on p. 114 of text it is given as 53° 01′ 45″. Krassilnikoff (see note 13), made it N. Lat. 53° 01′ and 158° 10′ E. Lon. from Greenwich, from eclipses of Jupiter's satellites.
[18] From the chart; the text, p. 114, makes it 51° 03′.
[19] The positions in this column are taken from the most recent charts of the U. S. Coast Survey and the U. S. and Russian Hydrographic bureaux.
[20] U. S. Coast Survey, 1880, Marcus Baker, observer; his position is reduced to the N. W. extreme of the island by adding 5′ of latitude and deducting 30′ 35″ in longitude. See Bull. Phil. Soc. of Washington, iv, p. 133, 1882, and U. S. Coast Survey Report for 1880, App. No. 16.
[21] Lieut. Onatsevich in Report Russ. Hydrographic office, 1878.
* This column is taken directly from Baron Klinckofström's manuscript copy of Bering's chart.

Resumé of the Results.

Bering had brought a party, together with supplies and material, over the rough and difficult but long-traveled routes to Okhotsk. Wherever he went he found settlements and roads such as they were. He transported his material to Bolsheretsk and from there across the peninsula to Lower Kamchatka settlement. It would have been much easier and shorter to have doubled the peninsula and taken his stores by sea; one of his party had already explored the straits near Cape Lopatka, but there was the chance of disaster in this plan and, with his stores on *terra firma*, Bering cannot be blamed for taking the land route; especially as the difficulties would not inconvenience him personally. He succeeded in getting his stores and shipwrights to the place designated and there prepared himself for the voyage. In all this there was difficulty and trouble enough of a certain kind. That it all was surmounted with success is very creditable to Bering and his officers. But to call it exceptionally heroic or extraordinary, is to forget the hundreds of others who preceded Bering, without the strong arm of the government at their backs, who made the trails he followed, who founded the settlements at which he rested, who raised the dogs, the horses and the cattle which were used or consumed by his party.

Whatever praise we may feel due to Bering and his companions, and it is certainly no stinted allowance, the appreciation of their struggles cannot fail to include with justice, the still more remarkable and nearly forgotten pioneer labors of the undaunted Siberiaks, who paved the way, not only for Bering's weary journey, but for the slow yet never ceasing march of civilization.

After leaving port Bering traced the shores of Kamchatka and eastern Siberia as far as East Cape. Thence he sailed in a northeasterly direction. At 3 P. M., Aug. 14th, land was seen astern; the vessel continued in the same direction until 3 P. M. the next afternoon, having, at most, sailed about twenty-four hours out of sight of land but in shallow water. Bering then concluded he had gone far enough to show the separation of Asia from America, or any land to the eastward. No doubt he was influenced by the testimony of the residents of Kamchatka who knew the work which had been performed in this region by Deshneff and others, and also by the fact that the native testimony all pointed the same way. If he was convinced of the truth of this testimony

he would have been disposed to accept as conclusive evidence which would not be so regarded by critics. All the evidence shows Bering as faithful to the letter of his orders, honest, patient with the ill-doing or insubordination of others, but perfectly satisfied with the accomplishment of what he had been specifically directed to perform, and with a tendency to limit the specifications to the narrowest construction they would bear. He adventured nothing beyond. In the arbitrary government under which he served, with the violent competition between foreign officers in the Russian service for promotion in rank and pay, who can criticise him for the prudence and caution which kept him well within his instructions? I certainly do not. But to say that he was a cautious, prudent and sagacious officer, is a different thing from asserting he was a daring, adventurous and heroic explorer. I have not been able to discover anything in his career justifying the latter estimate of his character.

At all events in the present case it must in time have occurred to him, or have been suggested by his officers or by the Kamchatkans after his return that the mere sailing off shore in admittedly shallow water for twenty-four hours, was not an absolutely conclusive proof that the continents were separated. Here was a man with a new vessel, a full crew, a year's provisions for all hands, who has come half around the globe, taking three and a half years to do it, building ships and at no end of labor of one sort and another; all this to get into the region where there is a question to be answered; and when he gets there he barely gives twenty-four hours to searching for that answer with a month of the season still available for work; and then starts for home without settling the question; with a right conclusion, it is true, but not of his own discovery, and without securing definite proof to defy critics.

Leaving out of account the continent within half a day's sail which he fairly ran away from, ignorantly, where is there anything adventurous, daring or heroic in such conduct?

It is evident that if Bering had sailed along the coast which the Chukchis said extended to the westward, instead of going off shore, away from it, he would have confirmed that part of their testimony, and given high probability to the assumption of their correctness in the rest.

As it was, he left the question in a state so unsettled as to be a subject of debate for nearly half a century; even authorities so

friendly as Dr. Campbell assuming with great confidence that Bering's conclusions as to the separation of the two continents were erroneous. It was not until the voyages of Captain Cook and his associates were given to the world in 1784 that the matter was settled beyond controversy.

Even in regard to the details of his voyage it was only through Bergh's publication of Chaplin's logbook of the voyage in 1823, that the public were informed as to what Bering did, and it was only in 1847 that the unmutilated, but still ambiguous Report of 1730 was accessible even in Russian typography.

We find that all the authorities who published in the last century copies of Bering's map and accounts of his expedition arrived at what Lauridsen calls an "interesting misunderstanding."

This misunderstanding was that he had sailed along the Chukchi coast, as above suggested, and that his farthest point was in latitude 67° 18′ on the coast of northeastern Siberia.

How was it possible that men of such exceptional intelligence as Du Halde and D'Anville and Müller, and Hazius, and Euler and Campbell were all so deceived?

The facts are as follows:

(1) The verbatim Report of the voyage, the logbook of the expedition, Bering's chart in its entirety, were inaccessible to the public for many years; the chart has never been fully engraved for publication.

(2) The fragments of the Report which were circulated in print were ambiguous in their language or erroneously modified; while the published reductions of the chart which got into print were misleading, or even erroneous.

(3) Two conflicting versions of the manuscript chart were circulated and appear to have been officially sent out. That which appears to be the later of the two is in some details quite erroneous and at variance with Bering's report as printed and with the facts derived from Chaplin's logbook, these two constituting the only authentic original information which has yet reached the public in printed form. But these two sources of correct data about the expedition were not printed until long after the charts had been widely circulated, while the extracts from the Report which appeared in print, even under so friendly an editor as Dr. Campbell were so modified as to support rather than expose the original error. How this arose there may be something in the Russian archives to explain, or, if not, the case

seems insoluble. Whatever conclusion one arrives at, it is difficult to acquit Bering of all responsibility for the misconception, if, as Lauridsen claims, he was responsible for the chart of Du Halde in the form it was engraved.

In his report he states that their northernmost latitude was 67° 18′, that "all along the seacoast to this place wind elevated mountains." On turning to the Du Halde chart we find the range of mountains continued along the Chukchi coast until it reaches the latitude of 67° 18′ where it stops. If Bering drew the chart so, it would have been deception, but it is quite as probable that the editor modified the chart in engraving it, to correspond to his understanding of Bering's ambiguity. As this would present nothing questionable to the reader, in the absence of the details omitted by Bering, it would have been nothing surprising if Campbell's interpolation of a false longitude for Lower Kamchatka, in his list of positions, might have been, not a typographical error, but an attempt to make the position agree with this erroneous assumption. If it was a pure accident, the coincidence is extraordinary. Of course Bering never was on this coast but Du Halde's map is so engraved as to lead directly to the false inference that he had been.

Again Bering says in his Report that at his turning point the land no longer extended to the north and that no projecting points could be observed in any direction. Since he had deliberately sailed away from the shores without attempting to follow their trend this observation would be absurd unless we suppose it addressed to a reader who took it for granted that the vessel was still skirting the coast. There is no mention in his Report of the fact that he had sailed away from the coast, nor of the still more important fact that the soundings showed that the water was comparatively shallow and discolored. Of course in the absence of direct proof of the separation of Asia and America this last evidence would tend to indicate that Bering was only in a bay or shallow arm of the sea and that he suppressed it shows, if not a want of candor, at least an injudicious reticence.

The map for the day when it was made (in the earlier version) was a good one, and is appropriately praised by Cook, who had a copy of Campbell's Harris on his vessel when exploring in the same region fifty years later.

In his report of the trip eastward from Kamchatka in 1729, Bering says nothing about the weather being foggy or stormy,

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In his report of the trip eastward from Kamchatka in 1729, Bering says nothing about the weather being foggy or stormy,

but merely asserts that he sailed nearly 200 versts and saw no trace of land. He leaves it to be inferred that he could have seen land if it had been there to see, which if the weather was foggy was not true.

The impression which these facts leave upon the mind is that Bering did certainly frame his language so as to convey the idea that his evidence of the separation of the two continents and of the absence of land eastward from Kamchatka was more conclusive than it was in reality.

That this was done to avoid criticism seems a natural inference. That an examination of his list of positions would have shown the location of the point whence he turned back to be to the eastward of the easternmost of his reported land is true, but his list of positions was not published with his report, does not agree with his maps, and when published by Campbell was garbled, as I have shown.

That the truth, however, did get out and that criticism was not successfully avoided, is a matter of history. There can be little doubt that Bering's anxiety to undertake the second expedition, which followed, was stimulated by a desire to set these criticisms (which would naturally be magnified by his enemies) finally at rest.

It may be suggested that Bering's report was modified by the authorities, though why they should make these particular modifications is not very evident. Bering was the only person who could profit by them and the natural conclusion is that he should be held responsible.

In pointing out that some of Bering's acts are vulnerable to criticism I am far from desiring to sully his memory or give the idea that he was not entitled to great praise for what he accomplished, much of which was admirably done.

I wish merely to apply a gentle corrective to the exaggerated and injurious flattery and undiscriminating praise which has been injudiciously indulged in by his latest biographer.

If the interest in the subject be stimulated by discussion from these opposing points of view, so as to result in the publication of some of the material still hidden in the Russian archives I shall be more than repaid for the time I have devoted to the question, even if the publication of the original data should show some of my conclusions to be ill founded or erroneous.

Note—The reception of the original work of Bergh while reading the proofs of these pages has enabled me to correct several errors of previous writers, but it was too late to incorporate here the additional material which Bergh's work affords. This will enable me to add, in a future publication, some historical data which have never appeared in English and which are necessary to complete the record. I desire in this place to express my gratitude for and appreciation of the liberality of the authorities of that ancient seat of learning, the University of Upsala, as exhibited in their willingness to send such a valuable document to a foreign student half around the world for purposes of historical research.

Supplementary Note by Marcus Baker.

ON THE ALLEGED OBSERVATION OF A LUNAR ECLIPSE BY BERING IN 1728–9.

Bering was in Eastern Siberia, Kamchatka and the adjacent waters in 1728 and 1729. Could he have observed a lunar eclipse there at that time?

According to the ephemeris of Manfred* published at Bonn in 1725 there were two partial eclipses of the moon visible in Europe in 1728, and two total eclipses of the moon in 1729.

In regard to these four eclipses the ephemeris furnishes the following data:

	1728, Feb. 24.	1728, Aug. 19.	1729, Feb. 13.	1729, Aug. 8.
Eclipse begins	$18^h\ 32^m$	$4^h\ 07^m$	$7^h\ 45^m$	$12^h\ 02^m$
Total immersion	-- --	-- --	8 46	13 02
Middle of eclipse	20 0	5 35	9 35	13 52
Emersion begins	-- --	-- --	10 24	14 42
Eclipse ends	21 29	7 03	11 25	15 42
Digits eclipsed	9 51 S.	7 45 N.	19 46	19 44 S.
Sun rises	18 36	-- --	-- --	-- --
Sun sets	-- --	6 49	-- --	-- --
Eclipse	Partial	Partial	Total	Total.
Sun's declination	$-9°\ 38'$	$+12°\ 42'$	$-13°\ 16'$	$+16°\ 09'$
" hourly motion	+ 0.9	− 0.8	+ 0.8	− 0.7

* Manfredius (Eustachius). Novissimae ephemerides motuum coelestium e Cassinianis tabulis ad meridianum Bononiae supputatae auctoribus Eustachio Manfredio (etc.) Tomus 1. ex anno 1726 in annum 1737 (etc.) 4° *Bononiae*, MDCCXXV.

In this table the calendar is Gregorian, the time is apparent or true sun time, the day is reckoned from noon and the hours are counted continuously through the entire 24.

The present observatory in Bonn is in

Latitude 50° 43′ 45″ N.
Longitude 0^h 28^m 23^s E. from Greenwich.

At the date of the *first eclipse* Bering was on his way across the southern end of Kamchatka from Bolsheretsk to Lower Kamchatka. This would make his position somewhere near latitude 55° N. and longitude 160° or 10^h 40^m E. from Greenwich.

He was therefore 10^h 12^m east of Bonn for which we have the elements of this eclipse as computed by Manfred. With this data together with the latitude and sun's declination we have the following data for the eclipse in the region where Bering was.

Beginning of eclipse	4^h 44^m
Middle of eclipse	6 12
End of eclipse	7 41
Sun sets	5 07

This means that the sun set, bearing about W. by S. ½ S., and the moon rose in partial eclipse, bearing about E. by N. ½ N., at 5^h 07^m after apparent noon or 23 minutes after the eclipse had begun. The eclipse lasted for 2^h 34^m after sunset, or until 7^h 41^m in the evening, thus rendering observation of the last contact plainly visible.

At the date of the *second eclipse of 1728*, August 19, Bering was at sea somewhere in the vicinity of the strait which bears his name. Assuming his position to have been latitude 65° N. and longitude 188° or 12^h 32^m E. from Greenwich, equal to 12^h 04^m E. from Bonn, and as before taking the data from Manfred's ephemeris we have as follows :

Beginning of eclipse	16^h 11^m
Middle of eclipse	17 39
End of eclipse	19 07
Sun rises	16 04

It thus appears that the first contact of this partial eclipse of the northern limb of the moon may have been just barely visible to Bering. The moon bearing about SW. by W. was entering the earth's shadow about five minutes before the sun's rising and its own setting. If much importance attaches to determining the possibility to Bering of observing this eclipse then a more precise calculation is needful.

At the date of the *first lunar eclipse of 1729*, February 13, Bering was at Lower Kamchatka, in latitude 56° 03′ N. and longitude 162° 15′ or $10^h\ 49^m$ E. from Greenwich equal to $10^h\ 21^m$ E. from Bonn. For this place we have from Manfred :

Eclipse begins	$18^h\ 06^m$
Total immersion	19 07
Middle of eclipse	19 56
Emersion begins	20 45
Eclipse ends	21 46
Sun rises	$19^h\ 21^m$

Thus it appears that this total and almost central eclipse of the moon lasting $3^h\ 40^m$ began at Bering's station 1^h and 15^m before sunrise of February 14, the total immersion occurring 14 minutes before sunrise. It is manifest, therefore, that Bering might have observed this eclipse.

The *second lunar eclipse of 1729* occurred August 8, when Bering was in or near Okhotsk and about returning to Europe. We may assume his position to have been latitude 59° 20′ N. and longitude 142° 40′ or $9^h\ 31^m$ E. from Greenwich, equal to $9^h\ 03^m$ E. from Bonn. This eclipse was also total and almost central, but at Bering's station was wholly invisible, beginning at $9^h\ 05^m$ A. M. and ending at $12^h\ 45^m$ P. M.